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PREFACE

After nearly three decades of research work in the history of statistics and statistical ideas in the widest sense, i. e. incorporating the fields of demography, economics, econometrics and sociology in the problems of research, I am arriving to publish these six essays in the history of Political Arithmetics and Smithianism. Despite the fact this publication is giving a very small sample of my results, I thought it useful to present them for the reader for two major reasons:

First of all, the six essays reunited in this form are forming also from the scientific point of view a coherent unity and may so break through towards a more broader synthesis of Political Arithmetics and Smithianism in connection with it. I regret not to be able to include at least a summary of my studies in the work of JOHANN PETER SÜSSMILCH, being short of time, and for the same reason, my study in the spread of Smithianism in Hungary. But even without these complementary essays I hope to have thrown some fresh light on the whole complex.

Second, even if some of the essays included in this publication have been published occasionally, it happened only and mostly in abbreviated form, even in summary sometimes, — or in different languages, inserted into congressional papers, even mixed up with not too-current, e. g. with Japanese articles. As Political Arithmetics and Smithianism were the products of English genius, I have choosen this language to reunite my six essays in full around the subject.

Szeged, December 1977.

THE AUTHOR

1.

SOME BASIC PROBLEMS AND HISTORICAL DEVELOPMENT OF POLITICAL ARITHMETICS RECONSIDERED

I.

Lacunes of the History of Statistical Ideas in Hungary

The problems and development of English and continental Political Arithmetics were playing an essential — if neglected — role in the development of statistics in Hungary and were contributing to the formation of a coherent Hungarian society.

The historiographers of the statistics of Hungarian capitalism and the critically minded scholars of the present socialist era have been concentrating their efforts till our days on descriptive statistics of German origin or „Staatenkunde". This current of thought was their main field of exploration in dealing with the origins of Hungarian Statistics. They were surely right so far that descriptive statistics took an overwhelming part in Hungarian scientific development, — but this fact furnished no statisfactory excuse for a nearly complete neglect of the questions of Political Arithmetics in Hungary. Political Arithmetics as a more scientifical branch of early statistics in the rising capitalistic period was not even mentioned by the literature on Hungarian statistics as regards the XVIIIth century and was only appearing sporadically concerning the XIXth century. Perhaps this omission was responsible for the fact, that representatives of this literature never reached the point of making a synthesis of the two main currents of early statistical thought in Hungary and they have not been able yet to give an enlarged picture about the complex reality and development of scientific ideas of Hungarian capitalism, — early Hungarian statistical thought included. The deficiencies of this conception are manifest not only in cutting off the two principal branches of early statistics from another, but also in isolating them from international development. But without their international sources, neither descriptive statistics, nor Political Arithmetics have ever been able to rise to scientific status, only on the factual basis of a retarded Hungarian capitalist development.[1]

However, to reach a synthesis of the two currents of statistics in Hungary two main problems are to be solved. First, a short and comprehensive critical theoretical appraisal is needed concerning the basic problems and historical development of Political Arithmetics in Hungary, — and as second —, a research into the latter problems, on the ground of the former.

The present study is an essay to solve the first problem on the basis of international scientific literature concerning the development of statistical thought in general and that of Political Arithmetics in particular, — completed

[1] The author has dealt with these problems in his monography "Professor Stephen Hatvani (1718—1786) and the Origins of Scientific Statistics in Hungary", Budapest, 1963. pp. 1—323. (Hungarian text with French and Russian summaries on pp. 309—317.)

partly by the research work done by the author of the present paper. A summary concerning his researches of the second problem was published already in Hungarian under the title: „Problems of Political Arithmetics in Hungary" in the Hungarian review Statisztikai Szemle, in 1959, — pp. 602 and further[2] and is summarized as the second paper in the present collection of essays.

II.

The Interdependences of Descriptive Statistics and Political Arithmetics (1. The Early period — 2. The Achenwallian Era — 3. The Emergence of Official Statistical Activity.)

1. It is an established fact, that Political Arithmetics as a current of statistical thought has had its origins from the sixties of the XVIIth century in England, — representing the ideology of the rising English capitalist classes.[3] These preponderantly mercantile classes had felt the need to develop a realistic picture of capitalist economy and society, — to be able to present new ideas in the fight with feudalism. That was one of the reasons why they were depicting the new order as the more „rational" and the more effective one to realise human happiness, — not only for individuals, but also for the whole new society, integrated in a new anti-feudal national state.

It is also a well-known fact, that facts concerning population, economy, politics and geography of a whole society were incorporated a little prior to Political Arithmetics in the form of „Staatenkunde" at the German University of Helmstett by Professor CONRING's established system of political sciences. This was introduced as a new discipline at the Faculty of Law and made a new start. Another new idea in the politcal arithmetical thought, — developed by PETTY and his school in opposition to scholastic superlatives — was the application of „number, weight and measure" and of „proportions" to the phenomena of human society.[4] Data footing on the „sensual experience" were able to give to the society her „anatomy", by analogy of medical sciences. This ana-

[2] A brief synthesis of the problems of Hungarian descriptive statistics was given by the same author in his "Development of the Descriptive Statistics in Hungary", Budapest, 1966., published by the Hungarian Demographic Institute, Nr. 13., pp. 1—131. (Hungarian text.)

[3] The following standard works may be consulted concerning this problem from Western sources: ONCKEN, A.: Geschichte der Nationalökonomie, I. Theil, Leipzig, 1902., — SCHUMPETER, J. A.: History of Economic Analysis, Edited from Manuscript by BOODY—SCHUMPETER, E., London, 1954, Reprint, — KNAPP, G. F.: Theorie des Bevölkerungswechsels, Braunschweig, 1874., — JOHN, V.: Geschichte der Statistik, I. Teil, Stuttgart, 1884., — WALKER, H. M.: Studies in the History of Statistical Method, Baltimore, 1931. and WESTERGAARD, H.: Contributions to the History of Statistics, London, 1932. — The author has served the following Marxian sources: OSTROUMOV, S.: The Main Periods of Development in International Statistics, *Statisztikai Szemle,* 1950., Nr. 11., pp. 734—745. (Hungarian translation from the Russian original) — and KASKAREWA, L.: Statistics in the Works of Marx and Engels, Statisztikai Szemle, 1951., Nr. 4., pp. 231—303. (Hung. tranl. from the Russ. orig.)

[4] Compare with HORVÁTH, R. A.: The Contribution of Netherlandish Thinking to the formation of Statistics as an Autonomous Discipline, 36th Session of the International Statistical Institute, Sidney, 1967., Contributed paper.

logy furnished the first denomination of „Political Anatomy", suggested by PETTY to this new current of thought.

The rapid modification of this name by the inventor served to underline more pregnantly the outstanding characteristics of this new branch of science: the use of numerical data for the explanation of political and social facts, establishing by this a „political" discipline, — rather than an abstract „mathematical" one.

The general idea of the early English political arithmeticians, — i. e. to investigate the new phenomena of rising capitalism by this arithmetically minded method not only in the field of population and economy, but also concerning the facts of the social and legal superstructure-, prepared the way to the application of statistical method in the widest sense in social sciences. Another fundamental scientific contribution of the Petty-school was the perception of dialectical relations in social life, the intuition of the existence of social laws and the need of their research with the help of this new method.

However, Political Arithmetics had not found the echo, — not even at its birthplace, in England —, which would have been appropriate to the splendid ideas of its early English representatives. This fact is unsufficiently explained — or at least partly — by the circumstance, that most of its representatives were men of praxis. Therefore the new scientific current has not found in this early period representatives at the universities and never became a university-discipline. At this time, when the influence of scholastics was not yet eliminated, this deficiency explains, why the spreading of Political Arithmetics was hindered even in the Western and Northern States of Europe, where capitalism progressed rapidly.

From this point of view the rival current of statistical sciences, descriptive statistics, shows a vivid contrast to Political Arithmetics. The Conringian „Staatenkunde" developed essentially as a university-discipline, in spite of difficulties in delimitation of its proper scientific subject. By the fact, that descriptive statistics was able to synthetize the elder disciplines of law, politics, history and geography and succeded in integrating the first qualitative results of the new social sciences of population and economics „in statu nascendi", it could satisfy for a long time the real needs of the Central and Eastern European States, where capitalist development was a very incomplete one. Particulary in Germany, at the birthplace of „Staatenkunde", the capitalist development was strongly retarded by the consequences of the Thirty Years'War. After the Treaty of Westphalen (1648) the territory of Germany was divided into not less than 300 feudal states, a situation which persisted parallel with the beginning capitalist economic transformation promoted mainly by the feudal state. So instead of mercantile and other capitalist classes the state clerks became the representatives of this development. They served the interest of state by making use in the government of this „super-science", wich integrated the newly invented political sciences with the established ones, and which linked the facts of the new economic development to general progress.

Thanks to this real political need, and to the university chaires, securing the institutional framework, the „Staatenkunde" had found quick territorial expansion, in spite of its conservative feudal character and in spite of the total absence — for its first time — of the use of numbers and data. This insufficiency was systematically covered by Professor ACHENWALL only from the fifties of the century on, i. e. from the XVIIIth century. We can speak only from this time on about the starting-point of the higher or Achenwallian period of descriptive statistics as against the lower, the Conringian one.

2. The far-reaching consequences of the formation of Achenwallian descriptive statistics were not always realised even in international statistical literature. Achenwallian statistics, thanks to its university position, was able to make important scientific progress and Political Arithmetics rised also to university status only through it. However this happened belatedly and not in the form of a separate discipline, but as a part of the new uniform science of „statistics" in the modern sense of the word.

To reach this level of evolution the first step was offered by the formation of the absolute monarchies on the European mainland in the XVIIIth century, with their specialised problems of administering extensive territories of numerous population on the basis of a market-economy. This process has led to the selection of a special branch of administration: conscriptions and censuses of population. The university professors representing the late „Staatenkunde" had realised that, by employing the data of administrators to describe state life, the new science could find its proper scientific subject in population and economics, but also it could improve its methodology.

By recognizing the importance of number in political science and by searching for new methods, they came to the discovery of Political Arithmetics and especially of its methods. Descriptive statistics at the end of the XVIIIth century was offering two alternative methods to find out the number of population in a given country: i. e. the census, or the establishing of the number of inhabitants on the basis of official statistics and the estimates on the vital statistical basis developed by political arithmeticians. Contacts between the two separate currents of statistics had became more and more frequent and led to the evidence, that there is no difference whatsoever between the two: they are components of the same science of „statistics". The formation of a unique and distinct statistical discipline in the capitalist sense made a huge progress at the beginning of the XIXth century by incorporating the methods and problematics of both currents.

3. The evolution summarized above made the existence of a separate Political Arithmetics naturally superfluous. Its survival was secured only as far as its estimates and extrapolations concerning the behavior of the social body were the sole means to fill the gaps in existing political knowledge. The development of population administration, furthered by the German and Austrian „Kameralistik" and also taken up by the great monarchs of Prussia and Russia, was from this point of view already a serious blow to the existence of Political Arithmetics. The formation of central statistical bureaus in state administration may be considered as the next step on this way, realised for the first time during the Great French Revolution and consolidated by the Napoleonic era in the year 1800.[5] Following this example, the institution of new statistical services was taken up by all principal states of Europe in the first half of the XIXth century and contributed essentially by practical and methodological experiences to the formation of the new „Statistics".

Some of the contributions of QUETELET have to be classed under this

[5] HORVÁTH, R. A.: An Appraisal of the Formation of a Hungarian Official Statistical Service, *Statisztikai Szemle*, 1958., Nr. 2., pp. 161—177. (Hung. text.)

heading, — as rightly pointed out by WESTERGAARD.[6] However, the existence of voluminous and detailed data, describing the social body, was not enough in itself to form a uniform statistics: the mass of data cried even louder for appropriate method. Administrators were awaiting from the mathematical science, from the calculus of probability the methodology of applications in social sciences.[7] The role of Political Arithmetics in the spreading and elaboration of such powerful statistical methods of probability theory was one of the most important contributions of this pioneer-branch of modern statistics. Without a somewhat more detailed analysis of it, this role would not be rightly understood.

III.

Political Arithmetics and the Development of Probability Theory (1. Problems of Methodology — 2. Differences in Demographic and Economic Applications — 3. The Unsettled Status of Political Arithmetics in the Social Sciences)

1. From the point of view of the mathematical foundations of Political Arithmetics, it seems to be clear that political arithmeticians — analysing social life through numerical data — ought to be men of mathematical faculties. They have had to possess not only a knowledge of practical applications, but also of some theoretical basis. The latter was not always preponderant, it was, however, quite necessary to reach important results in application.

At the same time, it is not difficult to find among political arithmeticians first class mathematicians reaching the highest level of their epoch, who were principally mathematical theorists with a wide interest in practical matters, — especially in social phenomena. The methods elaborated by the latters furthered not only mathematical theory, but also numerical methods of statistics considerably. The greatest role in this development was played by the calculus of probability. The most famous work in this field, the „Ars Conjectandi" by JAMES BERNOULLI, published posthumously in 1713, gave the first definition of the law of great numbers on the basis of earlier attempts.

This important work marks the starting point of the efforts of a whole army of mathematicians to analyse systematically the problems of probability and to find their best possible practical applications. The peak was reached by DE MOIVRE[8] and LAPLACE in the XVIIIth century by inverting the Bernoulli-theorem starting from "a priori" probabilities and arriving to probabilities "a posteriori", — i.e. to statistical induction. From the theory of averages and its applications in statistical methodology for social phenomena there was only one step forward, — realised by QUETELET from the thirties of the XIXth century on.

2. Political Arithmetics was making use of probability theory in two directions: first in calculations of life-rents, and second, in calculations of the mor-

[6] WESTERGAARD, op. cit.

[7] This problem forms clearly a chapter of the history of mathematics too with its applications, as rightly pointed out by WALKER, op. cit.

[8] Compare with HORVÁTH, R. A.: 300 Years Anniversary of the Birth of de Moivre, Statisztikai Szemle, 1968., Nr. 12., pp. 1240—1255. (Hung. text with Russ. and English summaries.)

tality of human beings and hence in vital statistics. In this development Holland was playing a preponderant role, as there rising capitalism produced very soon, at the end of the XVIIth century, a high standard of life for the mercantile classes. This situation gave a stimulus to life-rent practices, not possible without the knowledge of the laws of mortality and of the duration of human life. In this kind of profit-making was not solely the capitalist class involved but also the state with its financial operations — as described masterly by MARX.[9] Our third paper gives a wider exposition of this thesis.

Such antecedents played a considerable role in the work of such well-known theoricians as the first BERNOULLI, who incorporated the whole treatise of HUYGENS — the famous Dutch mathematician — in his "Ars Conjectandi", — or in the work of DE MOIVRE and other outstanding mathematicians of the XVIIIth century. The same factor was present in the activity of the famous Dutch philosopher S'GRAVESANDE, who was giving the first hints to the practical applications of probability theory, especially in the philosophical theory of epistemology. But the best theoretical foundation was given by DE MOIVRE, whose contributions are dealt with in our fourth paper in this collection.

The same is true concerning the activity of several earlier leading representatives of Political Arithmetics, — HALLEY, KERSSEBOOM and DEPARCIEUX, the latter being the author of the first systematic treatise on methodological problems of life-rents. Both kinds of problems can also be found in the works of SÜSSMILCH, who may be considered as the greatest systematizing genius of Political Arithmetics in the mid-XVIIIth century.[10] Thus life-rents problems played a leading role in the elaboration of mortality problems, including life-tables and establishing the number of standing population.

The situation was entirely different in the rising capitalist era in the field of economics. In spite of the outstanding and progressive ideas, the early English school of Political Arithmetics was only able to lay the foundations of descriptive methods of economic statistics, as the theory of economics and especially the understanding of the interdependence of its functions was nearly non-existent in the epoch. The birth of the first scientific school of capitalist economics, the Physiocracy, and its first applications of mathematical thinking in addition to it, opened the way to a new approach in this important field of modern statistics in the second half of the XVIIIth century.

DR. QUESNAY, its founder, — a disciple of the same BOERHAVE-school of Dutch anatomy as PETTY-, was searching also the anatomy and functioning of the organism of capitalist economy, but complementing it with mathematical abstractions in his famous. "Tableau Economique" from 1758. To progress from the abstractions to real economic data was a constant preoccupation not only of DR. QUESNAY, — as pointed out by MARX in one of his syntheses on the theoretical development of capitalist economics —, but also that of his disciples, especially of DUPONT DE NEMOURS.[11] The same line of thought is

[9] See his famous chapter on this problem in his "Capital", new Hung. translation, Budapest, 1949., Vol. I., pp. 810. and further.

[10] Compare with HORVÁTH, R. A.: "L'Ordre Divin" de Süssmilch, Bicentenaire du Premier Traité Spécifique de Démographie, *Population*, 1962., Nr. 2., pp. 277—288. (With English and Spanish summaries)

[11] HORVÁTH, R. A.: The Development of National Income Calculations in Hungary in the Capitalist Era, *Statisztikai Szemle*, 1956., Nr. 4., pp. 324—337. — with

to be found in the efforts of LAVOISIER, who worked out a macro-economic tentative for the French Revolutionary Government to find the actual number of the value of acricultural production of France. LAVOISIER had employed without any mathematical development a rudimentary approach of the representative method in his reasoning, as many political arithmeticians before him had been employing the law of great numbers exactly in the same way.[12] The methodology of the representative method was first given by LAPLACE in 1802, in his application of one of his famous laws of error, to correct the first census executed by the French official statistical service, i. e. the above mentioned "Bureau de Statistique", founded in 1800.[13] The activity of LAPLACE, footing on the unsatisfactory data of the rising official statistics, indicates the end of static Political Arithmetics and marks the beginning of the analytical period of a uniform statistics. The new era was characterized by the application of probability theory in statistical methodology, but was completed only three decades later — with all its merits and deficiencies — under the impact of QUETELET.[14]

To draw any conclusions from our above investigations concerning the development and characteristics of Political Arithmetics as a current of statistical thought, it may be said, that its "raison d'être" and in the same time its greatest deficiency of its evolution may be found both in the lack of reliable data and in the lack of an appropriate, strictly elaborated methodology. The nonexistence of established official statistical services was irreparable for the political arithmeticians. No elaborate census data, vital statistics and economic statistics were available, — so they were forced to work with secondary data or with scanty primary data supplied by themselves with hard work. This fragmentary material could be elaborated and analysed scarcely even with up-to-date methods, thus it is no wonder, that the pioneers of Political Arithmetics were sometimes completely hindered in their effective work.

However, their remarkable successes are showing, that their underlying ideas, — the numerical approximation of demographic, economic and other social phenomena emerging from the practical needs of the social progress, its dialectic logic and rudimentary mathematical methods —, stood on a solid basis and helped them to understand rising capitalism, at least in some of its essential aspects. Thus Political Arithmetics, by fighting against the rigid and outdated feudal ideology, has fulfilled a progressive and civilizing role in European development. However, this role was not entirely unambiguous. Some years ago the soviet statistician OSTROUMOV has drawn our attention to the inherent limitations of Political Arithmetics, in his synthesis concerning the main currents of statistical thought, which deserves attention.

3. I perfectly agree with the opinion of Professor OSTROUMOV concerning

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reference to the "Anti-Dühring" of ENGELS and to its chapter written by MARX. (Hung. text.)

[12] Ibidem.

[13] HORVÁTH, R. A.: The Historic Development of Statistics in France with a Special View to Hungary, *Acta Universitatis Szegediensis, Juridica et Politica,* Tom. XIV. Fasc. 4., pp. 1—126. Szeged, 1967. (Hung. text with English, French and Russian summaries.)

[14] Concerning the Marxian criticism of the Queteletian conceptions of capitalist statistics see HORVÁTH, R. A.: Die Beiträge von Marx zur Grundlegung der statistischen Wissenschaft, *Wirtschaftswissenschaft,* 1955. Nr. 1., pp. 61—79.

the absolute character of the social theories represented by political arithmeticians in the XVIIth and XVIIIth centuries.[15] Their efforts to present the characteristics of rising capitalism as the "highest" and most "rational" social order were surely necessary to propagate the new order against the old. But in the same time their ideas were exaggerated and paved the way to the apology of the same capitalistic order. However, these claims were fulfilled by very few representatives of Political Arithmetics, as many of them were forced to make greater or lesser concessions to the existing feudal order.

From this point of view SÜSSMILCH can be considered as a typical example. That is the reason why I can not class him as an outspoken "reactionary" scientist. I think, by elaborating the main, basic demographic and economic elements of the continental capitalist system and amalgamating it into a first tentative of a new social science, i. e. demography, he was far more an outstanding political arithmetician and even more than that. Surely, though a rational philosopher, he was making far-reaching concessions in favour of religious ideology and politically in favour of the semi-feudal enlightened monarchy. His argumentation interpreted social laws as the work of the "supreme and infallible, most accurate Arithmetician", i. e. of God. Every attempt to change them was presented not only contrary to the State, but also as a crime against religion and condemned to failure. In this connection similar concessions of other outstanding political arithmeticians should not remain without mention. Even prior to SÜSSMILCH, BERNOULLI and DE MOIVRE arrived from their calculations of probability theory and its applications to the demonstration of some kind of "Divine Order".[16] Similar conclusions may be also found — in view of the complicated bifurcation of chatolic or protestant scholastics and enlightened rationalist philosophy — in the writings of DESCARTES himself as concessions in the field of scientific cognition to ecclesiastic and state power.[17] With the victorius progress of enlightment these concessions became more and more formal and manifested themselves in the lip-service paid to such outdated theses, as the Derhamian "Physico-Theology".

It is howerver important to stress the differences in the manifestation of hostility between state and ecclesiastic power and Political Arithmetics. Ecclesiastic power, while oppressing new and nonconformist scientific ideas, was very cautious and intervened mainly indirectly, — being already in this time a second-rank power behind the absolute state on the European continent. State-power, in contrast, exerted an outspoken direct effect on the representatives of Political Arithmetics. Its reprisals were hindering directly the spreading of political arithmetic ideas and were discouraging new representatives. To cite a few examples, we mention the recent biography and appraisal of PETTY from STRAUSS,[18] expressing the view, that the fragmentary character of his oeuvre may be attributed to the Restauration Government of the Stuarts, which exerted an oppressive and slowing-down effect on PETTY's intellectual performance. Another example may be furnished from the last years of Marshall

[15] OSTROUMOV, op. cit., p. 737.

[16] HORVÁTH, op. cit., under (10) and (8)

[17] The contradictions of the Cartesian system are dealt with in LEFEBRE, H.: Descartes, Budapest, 1949., pp. 97. and furth. (Hung. transl. from the French original.)

[18] Compare with STRAUSS, E.: Sir William Petty, A Portrait of a Genius, London, 1954., p. 142.

VAUBAN in France.[19] He had lost — without any doubt — the favour of his monarch, LOUIS XIV, because of his progressive scientific and political ideas. The spreading of his writings and his original ideas were even before that hindered by legal obstacles, i.e. general censorship. An analogous fate was reserved — half a century later — to the ideas of SÜSSMILCH in the Hapsburg-Empire under the reign of MARIA THERESIA, his chief work being banned from the entire monarchy not to influence by its "dangerous" social content the Hapsburg-underlings.[20]

The list of examples may be continued to support the supposition that a considerable number of the representants of Political Arithmetics in Central — and Eastern-Europe,[21] were absolving a "tour-de-force" to avoid the dangerous consequences of state intervention: by adapting their progressive ideas to the needs of the absolutistic, semi-feudal, semi-capitalist state, — demonstrating thus the usefulness of their science. The result of their behaviour was not very different from the theological thought of line stated above, arriving to similar conclusions but in a very different way. Another possible solution of this dilemma was presented by avoiding any kind of social arithmetics and to escape to the abstract theoretical reasoning. Many representatives of Political Arithmetics chose this road and contributed thus to the formation and development of theoretical political economy, and especially to the theory of population incorporated to it. The latter development paved the way for MALTHUS and for his theory of population.

Among the limitations of spreading of Political Arithmetics as the more progressive branch of early statistics, I only want to mention one further essential feature, issued not from exogeneous, but from endogeneous forces of scientific development. It may be identified with the versatile character of this branch of science It covered the universe of social sciences entirely and by neglecting any clear-cut definition of Political Arithmetics as a current of thought or as an autonomous discipline, the possibility of further scientific development was blocked.

This omission played a preponderant role in creating an unfavourable situation as regards the system of established sciences in the late XVIIth and through the entire XVIIIth centuries. An important factor of this situation was the outspokenly practical interest of the best representatives of Political Arithmetics. Even if they were scientists, they were working in the field of established sciences and searched primarily for new applications and not for a new science. The best brains of Political Arithmetics recognized in vain the essentially social scope and character of their statistical calculations, — as in the case of PETTY, HALLEY, VAUBAN, KERSSEBOOM, DEPARCIEUX or LAVOISIER —, this vague and dispersed thinking could not accumulate in a form

19 ESMONIN, E.: Quelques Donnees Inédites sur Vauban et les Premiers Recensements de la Population, *Population,* 1954., Nr. 3., pp. 507—512. (With English and Spanish summaries.)

20 SCHWARTNER, M.: Statistik des Kőnigreichs Ungern, Ofen (Buda), 1798., pp. 68. and furth.

21 In Hungary the two leading spirits of capitalist development, Prof. HATVANI and BERZEVICZY (1763—1833) may be considered as typical examples from this point of view, — compare with HORVÁTH, op. cit. under (1) and from the same author: The Economic and Demographic Ideas of Gregory Berzeviczy, *Acta Univ. Szegediens.,* Jur et Pol., Tom. XI., Fasc. 7., pp. 1—34., Szeged, 1964. (Hung. text with Russian and French summaries.)

of a unique and separate discipline, but it dispersed around other established social sciences as public administration and law, public finance, economic policy and political economy. /

IV.

Questions Arising from the Periodization of Political Arithmetics (1. The General Location in Time — 2. The Proposed Four Subperiods — 3. Differences in the General Pattern of Evolution.)

We are far from pretending that the above factors, influencing the development of Political Arithmetics either in the affirmative or in the negative sense, are dealt with exhaustively in our rough outline, — however, perhaps some of the most important ones are listed. From the point of view of scientific history we have only to supplement them — in strict connection with our exposition — with one additional question, i. e. with that of the classification of the periods of evolution of Political Arithmetics in general.

1. In accordance with the findings of our essay concerning the origins and sources of Political Arithmetics, its first appearance and main influence may be counted from the discoveries of PETTY and GRAUNT in this field, i. e. from the sixties of the XVIIth century and its disparition from the beginning and middle of the XIXth, — corresponding to the period of the victories of bourgeois revolutions outside England. The establishment of the bourgeois classes and that of capitalist order on the European continent are closing the era of Political Arithmetics in the proper sense, — its place being taken over by the uniform discipline of "Statistics", firmly established around the middle of the XIXth century. However, this long-drawn-out period of the birth and spreading of Political Arithmetics was not in its entity a homogeneous and monolithic era, but has fallen into some distinct subperiods, which could be delineated in the following way:

2. a) The first subperiod may be defined as the era of great scientific discoveries and entreprises, containing the rise of Political Arithmetics in both of the two main fields of activity, i.e. demographic and economic statistics. Its duration from the sixties of the XVIIth to the first decade of the XVIIIth century is overshadowed in England by the personality of PETTY and his "school" and — if not so definitely — by Marshall VAUBAN in France.

b) The second subperiod may be considered as beginning with an "era of stagnation" in Political Arithmetics, — according to one of the most outstanding historians of statistical thought, to WESTERGAARD.[22]

c) This so-called "stagnation" lasted till the forties of the XVIIIth century and resulted in a second revival, marked notably by the activities of English and French, but also of German, Swiss and Swedish representatives of Political Arithmetics in the next two or three decades.

d) A fourth subperiod — not very easy to delineate explicitly — may be identified from the last decades of the XVIIIth and from the beginning of the XIXth centuries. This era is characterised by the strong bifurcation of continental descriptive university statistics and that of Political Arithmetics, — under

[22] WESTERGAARD, op. cit.

the double influence of the rising official statistics and that of the practical applications of probability theory. The result of this process was a slow, but inevitable disparition of Political Arithmetics and the definitive establishment of a uniform statistics from the thirties and by its overwhelming domination from the fifties of the XIXth century.

From this time on Political Arithmetics may be stated not only as a fading, but as an outspokenly outdated branch of statistics, with a rapid disparition in the third quarter of the same century. This disparition is also marked by the semantical transformation of the term "Political Arithmetics" itself, which designs from this time on the subject matter of insurance mathematics, — as already equally pointed out by WESTERGAARD.[23]

3. However, this general pattern of development of our synthesis corresponds more to the Western European spread of Political Arithmetics and is related most closely to the history of this branch of knowledge in England. The wide varieties of the evolution of this discipline may be best illustrated by the example of Hungary, — a typically underdeveloped country from the capitalistic point of view during the time-span under consideration.

In Hungary the first period of Political Arithmetics corresponds roughly to the above mentioned third period, and the second Hungarian one to the fourth generalized subperiod. The two subsequent subperiods are lagging considerably behind the main European scientific development in this field, for the third Hungarian subperiod is only in full development in the forties of the XIXth century and the disparition of Political Arithmetics, i.e. the fourth subperiod, lasted in Hungary only one short decade: the sixties of the same century.

V.

Some General Conclusions

What are the conclusions — of a general character — to be drawn from our reconsideration of the problems of Political Arithmetics represented by our rudimentary synthesis?

Yours author is disposed to say that first of all the transition in scientific methodology from a conventional type of "history of statistics" to up-to-date scientific history must be stressed. This transition, with its complex problems and its complicated sociological basis, was greatly furthered in Western scientific thought by the spread and influence of a "history of scientific analysis" in the Schumpeterian sense and by the revival of Marxist scientific thinking under the impact of XXieth century socialism.

A second conclusion of a general character may be stated as the result of the first in the following way: a reconsideration of the evolution of Political Arithmetics in the light of the problems of related disciplines and that of social and economic history may help considerably to underline the main trends of scientific development in general, but also is useful in the identification of important time-lags or territorial differences in scientific thought. By elaborating more clearly significant variations and alternative developments in scientific evolution, the wide variety of the historic past may be better understood and approached to and through this refinement of methodology it certainly comes nearer to historic reality.

[23] Ibidem.

2.

THE DEVELOPMENT OF POLITICAL ARITHMETICS IN HUNGARY
(A Synthesis)

I.

The origins of political arithmetics in Hungary — according to my latest researches — may be found in the spreading of modern mathematical science in this country.[1]

The existing intensive international relations of the Old Helvetian College of Debrecen made it possible for the first time, that probability theory and its calculus appeared in the middle of XVIIIth century in Hungary. This doctrine developed by *James Bernoulli* at the University of Basle and incorporated into the philosophical theory of cognition in the works of the Dutch philosopher *s'Gravesande* —, was available in Latin original in the forties of the XVIIIth century in the library of the Old College in Debrecen.

Perhaps some of these new exploits were mentioned or commented in the mathematical and philosophical lectures of Professor *George Maróthy,* — a scholar of great erudition. *Maróthy* himself studied also in Western countries, i.e. in Helvetia and was the best teacher of *Stephen Hatvani,* an outstanding disciple of the high school in Debrecen and later, from 1749 on, a professor in it for several decades. He was — without any doubt — the first Hungarian scholar, who made his own personal contribution to the history of probability in Hungary. *Hatvani* was not only introducing probability theory on the basis of his Swiss and Dutch studies, but he was also applying this new kind of discipline to practical subjects. For all that he has to be considered as the first representative of political arithmetics in Hungary, according to my researches.

II.

Hatvani has published his latin philosophical manual — entitled "An Introduction to the Study of the Principles of a More Consolidated Philosophy" — in 1757 in Debrecen for his students.[2] The whole third part of it was containing the exposition of probability theory as a new kind of philosophical cognition theory and some of its practical applications. The theoretical part of his text

[1] *Horváth, R.:* Étienne Hatvani et les origines de l'arithmétique politique en Hongrie, Population, 1959. N. 4. (Stephen Hatvani and the origins of political arithmetics in Hungary, — French text)

[2] Introductio ad Principia Philosophiae Solidioris conscripta a *Stephano Hatvani,* Med. Doct. et Philos. Prof., Debreceni, A. D. 1757., Caput III. under the heading: De Probabilitate. (Introduction to the study of the principles of a more consolidated philosophy written by *Stephen Hatvani,* Doctor of medical sciences and professor of philosophy, in the year 1757, in Debrecen, — Latin text.)

is showing a marked influence of the fundamental work of *James Bernoulli*'s "Ars Conjectandi" and that of the "Introduction to Philosophy" written from the above mentioned Dutch philosopher, *s'Gravesande*. The practical part of the third chapter of *Hatvani*'s work was characterized by the strong influences exerted by the works of the Swiss professor of mathematics and medicine, *John Gessner*, and the well-known French theorician of life-rents problems, *Deparcieux*. Influences by the latters are demonstrated by the fact, that *Hatvani* made his approximation to political arithmetics via the medical science and that of life-rents calculations. Scientific influences from Holland may be felt not only in the philosophical conceptions through the ideas of *s'Gravesande*, but also in the extension of applications of probability theory to the field of meteorological observations.

The lectures of *Hatvani* on the application of probability theory are culminating in the exposition of the problem of infant mortality and in the analysis of its main causes, demonstrated of his self-collected data of the city of Debrecen from the years 1750—54. Another special merit of *Hatvani* lies in the fact, that he was the first publisher of life-tables in Hungary having reproduced in the appendix of his work the three best mortality-tables of his epoch, that of *Halley, Kersseboom* and *Deparcieux*.

The deliberations of *Hatvani* should be highly esteemed by the scholar of our days. Not only their scientific basis was solid, but also his performance to find a way from the mathematical law of great numbers to the statistical induction was remarkable, — even when without mathematical development and on purely logical grounds. His characteristic line-of-thought has followed this kind of argumentation: After having introduced the third part with the exposition and formulation of the law of great numbers according to *Bernoulli*, he gave applications from the field of life-duration and mortality. He developped the probabilities of life-duration for one, two or more persons, and at least for a whole population, with the appropriate mathematical formulas. The same line-of-thought is applied for probabilities of death, — the necessary numbers being calculated from the above mentioned mortality-tables.

It is evident from the text, that *Hatvani* recognized clearly the death rates and that of survivors as the two main variables, serving as a basis for the calculation of life-tables through the different chances of different ages. On this theoretical basis supplemented by the numbers of the mortality-tables mentioned above, *Hatvani* was in the position to refute the widely held error about the dangers of "climacteric years", i.e. years divisible with the number seven. The ascertainment of the strong accumulation of the chances of death at the youngest years of human life was the next step, marked clearly in the Halley-table and confirmed by the arguments of medical science and by the experiences of his own medical praxis. *Hatvani* was finding on this basis not only the fact that children are more exposed to the dangers of death, than other classes of age, but moved to the numerical ascertainment, that, — according to the Halley-table —, half of a given generation is dying out during their first seven years. Among these seven years fare more the dangerous is the first one. That was one reason, why *Hatvani* wanted to demonstrate it on actual numbers, to be able to attack the problem from a new angle. The main difficulty was to observe the whole city population of Debrecen to dy out, because of the lack of trained statistical personnel and the necessarily long duration of the observation. By giving the number of Debrecen-born children in the age

0—1 separately for the five years of 1750—54, and that of children dead in this same period, also sorting out the numbers of them who died of the main cause of infantile death, i.e. the "diarrhoea infantile", *Hatvani* has thrown a distinct light on this very disastrous phenomenon of the epoch. His numerical results recalculated in crude five years average are showing, that the rate of infant mortality in Debrecen in his time was 295,3‰, and that of diarrhoea-mortality amounted to 229,2‰ of it.

Hatvani commented the high infant-mortality of Debrecen very intensively in his manual, venturing also in the field of social repercussions of this special problem. He concluded, that the high rate of infant-mortality may be attributed not only to physical, i.e. to medical causes, but also to social phenomena of a complex character. Among others he was listing as outstanding determining factors the low cultural level of the parents, the lack of satisfactorily trained midwifes and that of cheap and widely distributed medicaments. He was also mentioning the responsability of city and district magistrates for not having had reformed this deplorable state of affairs.

On a similar line of argument has *Hatvani* deducted the necessity of statistical observations of weather conditions, — playing a substantial part in the spreading of epidemics and rheumatical diseases. The continuous meteorological observations realised in Holland by professor *van Musschenbrook* — another of *Hatvani*'s masters — served him as a basis for the preparation of weather-prognoses, — which on their turn, were predicting the mass-appearances of weather conditioned epidemics and diseases. Informations of this kind are indispensable for better curing, — that is the summary of the ideas of *Hatvani*. Unfortunately, I was not able to find any meteorological statistics in the scientific heritage of *Hatvani* so far, — but his activity on this field is more than confirmed. The fact, that he was offering his results of meteorological statistics in his manual for publication to some would-be Maecenas — whom he was not able to find because of lack of interest — speaks for itself. As a practical conclusion of his meteorological work, *Hatvani* was proposing the drainage of the great marshes situated south of Debrecen, to avoid the perpetual infection of the atmosphere of the city.

The erudition and the statistical vein of *Hatvani* is clearly shown by the critical remarks, which he has added to the three mortality-tables, reproduced in the Appendix of his work from the Gessnerian pamphlet entitled "De Termino Vitae" from the year 1748. The Halley-table is appropriate only for the use in bigger towns to bring a scientific analogy, — according to the opinion of *Hatvani* —, and only when their atmosphere is healthy enough. The origin of the Kersseboom-table was quite a different one, having as a basis the data of a whole province, — together with data of rent-payers, the latter representing a selected population of better financial conditions. This double basis is responsible for the usefulness of this table everywhere. The most restricted application is to be confined to the Deparcieux-table, wich was selected from data corresponding to a population of rent-payers and that of some religious orders, — according to the remarks of *Hatvani*.

The performance of *Hatvani*, concerning the scientific application of probability theory and its use for applied knowledge was, in comparison with other performances on the same subject, an excellent one and especially valuable on the field of his investigations on the problem of infant-mortality. However, he avoided to introduce political arithmetics formally as a new science in Hungary. The reading of his text gives the impression, that the causes of this strange behaviour of his should not be entirely sought in his outstanding intellectual modesty. We have not to credit the wording of his "foreword", stating modestly that the one or two new observations are not authorising him to lay the foundations in new branches of some yet unknown sciences in Hungary. But when refusing to employ scholastic and axiomatic scientific systems and the repetition of often digested truisms, he leaves behind him descriptive statistics, — also abandoned by *Petty.*

I think, the fear of state censorship, executed by the strongly anti-Süssmilchian Jesuits in Hungary, and fear of his own othodox-minded Calvinist Debrecen-parochy might have played a part in the cautiousness of *Hatvani,* — being not only a professor of philosophy and a medical doctor, but also a Calvinist priest, — exercising from time to time his ecclesiastic profession, too. Notably, *Hatvani* in spite of his being a believer, was making a strict separation in the questions of science and religion, far more so, than *Derhàm* and his followers. The only pious wording of his terminating phrases is absolutely formal, if very similar to Derhamian Physico-Theology.

The fondness of *Hatvani* of political arithmetical ideas may be shown also by his interest in technical problems of agricultural production. He was giving a very far-sighted programme of the development and propagation of capitalistic production techniques in his professoral inaugural adress in the year 1749. As newly nominated professor of practical philosophy and mathematics in the Old College of Debrecen, he was lecturing about the usefulness of mathematics in other sciences. He insisted especially on the special significance of agriculture from the Hungarian point of view and on the necessity of the innovation of its techniques through the spreading of mathematical knowledge.[3] His later lectures in mathematics, physics and chemistry are a fulfilment of this programme. Unfortunately, the contents of these lectures are known — in a considerable part — only indirectly, with intermediary of student materials and by the concluding facts in the activity of some of his best pupils.

III.

Two of them, *Samuel Tessedik* and *Francis Pethe,* became the apostles innovating the Hungarian agricultural technique, — the first making also contributions to early Hungarian demography and economic statistics and the second to economic arithmetics and business accounting. Both of them were playing a decisive role in the founding and development of the youngest branch of capitalistic sciences, that of political economy.[4] The impact of *Hatvani's* ideas may be felt also in the works and activity of two of his other pupils, called *Stephen Weszprémy* and *Joseph Csapó,* both of them medical

[3] *Hatvani, S.:* Oratio Inauguralis de Matheseos Utilitate (from the year 1749), Museum Helvèticum, 1751. Particula XX., Turici, pp. 531. on. (Inaugural adress delivered on the usefulness of mathematics, — Latin text)

[4] A brief summary of the latest researches of the author of his essay in this field is to be read under the title: Hatvani István és a magyar közgazdasági irodalom kezdetei, Közgazdasági Szemle, 1960. N. 1. (Stephen Hatvani and the first appearance of economic science in Hungary, — Hungarian text)

doctors, working especially as municipal doctors responsible for public health questions and developing scientifically the care of children in Hungary.

It must be noted, however, that the activity of the pupils of *Hatvani* happened under entirely changed economic and social conditions as that of their master. The consolidation of Hapsburg-rule over Hungary, the spreading of a system of imperial economic policy of a mixed mercantilistic-physiocratic type emanating from the strong personality of emperor *Joseph II*, were promoting agricultural, but handicapping Hungarian industrial capitalism considerably. The same process was in progress in the field of cultural policy, where in higher education the period was marked by the transplantation of the former Jesuit-University of Nagyszombat (Tirnavia) as a state-university to Buda in 1777 and later to Pest, working under the guidance of the University of Vienna. Parallel with this process the Old College of Debrecen and the idea of a national university were declining. The same fate was reserved to the city of Debrecen, with his nationalistic-minded bourgeois-class, loosing succesively ground against the bougeois-classes of Buda and Pest, and the strong underlying influence of German, i.e. Austrian culture. In consequence of these changes independent and free capitalistic development in Hungary was slowed down and came under the impact of Hapsburgian imperial interests.

IV.

The center of Hungarian statistical science in this new period after *Hatvani*'s activity was shifted forcibly to Pest, where the Hungarian statistics found a new outstanding representative in the person of professor *Martin Schwartner*, — one of the two best representatives of late descriptive statistics in Hungary, — together with *Fényes*, following him half a century later. *Schwartner* as a Lutheran-protestant worked hard in the last decade of the XVIIIth century and in the first of the XIXth to obtain the chair of statistics at the state-university of Pest, but his succes was only a partial one. He became professor of diplomatics, but never a professor of statistics. *Schwartner* proved in vain in his "Statistics of the kingdom of Hungary", published in 1798, that he far outstepped all other representatives of Hungarian descriptive statistics both in his conceptions and erudition, in vain did he forced his greatest literary opponent the ex-Jesuit *Michael Horváth* in a bitter discussion to adopt the same conception, — the first permanent chair of statistics in Hungary fell to second-rank personalities. *Schwartner*, when depicting statistically Hungary of his days after the data of the census of *Joseph II* in 1784—87, was obliged to make an essential concession. He had to consider the state interests of Hungary as resting within the Hapsburg-empire, in spite of his efforts to transplant the economic ideas of *Adam Smith*, forwarding the autonomous development of a national economic system.

Schwartner was regarded in the Hungarian statistical literature as the first serious statistician till the middle of the XIXth century in Hungary, who was making also the first ventures into political arithmetics.[5] *Hugh Márky*, the

[5] See the references in *Schwartner*'s first edition, op. cit., pp. 69. on and in the second edition under the same title, Pest, 1809—11., Volume 1. pp. 75. on (Both editions German text)

Hungarian historiographer of statistics went further, when he considered *Schwartner* as the first statistician in Europe, who made a succesful attempt to unite the two early branches of statistical science.[6] From our line of thought therefore it is of peculiar interest, to recapitulate the conceptions of *Schwartner* concerning political arithmetics. In the above mentioned book of his *Schwartner* introduced political arithmetics as a problem of the history of statistics in connexion with the location and geography of population, based on the scientific activity of *Graunt* and *Süssmilch*. When depicting in this first edition the numerous marshes of Hungary, he stated the high mortality as a consequence of them. Opposite to this, in the second enlarged edition of 1809—11. this problem figures as a problem of "medical geography". Under this heading *Schwartner* had listed a lot of fragmentary data of marriages, births and deaths, collected by him from all over the country. These very data were analysed the first time in the Hungarian statistical literature only by *Lewis Láng* at the beginning of the XXth century.[7]

The second edition of *Schwartner*'s monography is leaving an impression, that the investigation of mortality was considered by him at the time as a problem of medical science, besides a statistical one. The similarity to the ideas of *Hatvani* is close enough, — in spite of the fact, that *Schwartner* must had been quite unaware of the exploits of *Hatvani*. This hypothesis is also confirmed by the fact of essential importance, that *Schwartner* never mentioned the application of the probability theorem, neither by citation of original sources, nor according to the work of *Hatvani*. A comparative analysis of *Schwartner*'s text as in the first and in the second editions reinforces, that he incorporated his ideas on the nature and significance of political arithmetics first in the investigation concerning the general characteristics of the population. Later, — in the second edition —, the problem appears under a separate heading, bearing the title "The lack of general Hungarian matriculation-data".

The general line of argument starts in this clear-cut part from the statement, that in some European countries people were finding the highest art of statemanship in the analysis of the number of population, and in that of its decomposition after several important characteristics, i.e. according occupation and vital statistical indices. This experience and procedure has given rise to political arithmetics as a new science. But the importance of numerical data in political life was known much earlier, for instance by the ancient Romans, who were — according to *Schwartner*, with a reference to the book of the German statistician *Schmelzer*, published in 1787 —, applying also probability calculus for similar purposes. Unfortunately, *Schwartner* has not given any further specifications on this problem, but was continuing his exposition with the well-founded statement, that the laws of deaths and births were only solved the first time in scientific history by *John Graunt*. He was the founder of political arithmetics in the proper sense, i.e. the founder of a new discipline, which culminated in the activity and work of *Süssmilch*.

[6] *Márky, H.:* Schwartner Márton és a statisztika állása XVIII. és XIX. század fordulóján, Budapest, 1905. P. 121. (Martin Schwartner and the state of statistics on the turn of the XVIIIth and XIXth century — Hungarian text.)

[7] *Láng, L.:* A statisztika története, Bevezetésül Magyarország statisztikájához, Budapest, 1913., pp. 67. on. (The history of statistics, A preliminary to the statistics of Hungary, — Hungarian text)

Schwartner was quite aware of the fragmentary character of his Hungarian Political arithmetical data as compared with the data of *Wargentin* including the whole population of Sweden. His critical qualities are also shown in the clear recognition of the inherent dangers in hastily drawn conclusions from fragmentary data, — and especially by his realisation of the wide differences in the interpretation of the newly found laws. *Schwartner* cited the exemples of *Süssmilch* and *Malthus*, as the two possible extremities in this field, — without delineating clearly his own position. His text — however — points to the direction, that he sought the solution of the newly found laws primarily not in theology or economics, but in medical science. That may be the reason, that he has terminated his deliberations on political arithmetics with the proposition for medical men to publish more developed Hungarian vital statistical data. He was looking forward especially for the publication of a certain doctor *Márton,* compiled from his own medical activities in the district of Pest.

It is interesting to quote, that the conception of *Schwartner* about political arithmetics was surpassed by him in several aspects, — nearing to the more advanced economic thinking represented by the classical English political economy. *Schwartner* when sharply pointing out the antagonism existing between the interests of landed aristocracy and that of general social progress, or that of the distribution of revenues, was attacking the same capital problem, which was exposed by *Adam Smith* and mastered only later by *Ricardo*. He was leaning considerably on the life-work of *Tessedik* when analysing the causes and consequences of the retardation of Hungarian agriculture. Sometimes here he attacked also the imperial idea of a united economic development of the Hapsburg-Monarchy, pointing out sharply the political hindrances of Hungarian commerce, not only the geographical and economic ones. All this seems to justify the opinion, that *Schwartner* has known the work and activity of the best pupils of *Hatvani* in more than one field, but probably the original contribution of their master and especially the statistical application of probability theory escaped him. This was the only aspect in which *Hatvani* was superior to him.

V.

Schwartner has had a deep and long-lasting influence on the development of Hungarian statistics, but this influence was a very onesided one, because of the relatively modest and not wholly up-to-date place of political arithmetics in his system. This circumstance coupled with the overwhelming rule in political science of the outdated Viennese-school of *Sonnenfels* throughout the whole empire, and later the regime of the Saint-Alliance has overshadowed entrirely also the contributions of *Schwartner* in Hungarian political arithmetics. His epigons from the second decade of the XIXth century on were only imitating his exploits in the field of the statistical description of Hungary, neglecting not only the heritage of *Hatvani,* but also that of *Schwartner* himself on the political arithmetical field.

One of his best immediate followers, *Paul Magda,* made an outstanding performance by penetrating the statistical description of his country with a strong national spirit and with progressive, nearly revolutionary political ideas, — but he was more preoccupied with the economic problems of agriculture, than with that of demography or statistics in the proper sense.[8] This line of statistical literature in Hungary was followed steadily by other writers of the epoch, making an important political contribution to the period of the "Reform-diets", beginning in the year 1825 and ending with their adjournement in 1844, leading straigthly to the bourgeois revolution in 1848 and to the war of independence of 1848—49.

From this point of view it is a fact of overwhelming importance, that the only disciple of *Hatvani,* who reached the professorial status in the Old College of Debrecen at the beginning of the XIXth century, *Daniel Ercsey,* succumbed also to the strong influence of *Schwartner.*[9] *Ercsey* in his "Statistical Compendium", written in 1814 in Hungarian language for his audience, developed much more the description of Hungarian economic conditions — on the basis of advanced cameralism and that of classical English political economy — than the demographic problems according to the system of *Hatvani.* In the second part of his work he was compiling simply the data of *Schwartner.* This strong influence of the University of Pest was fortified by the fact, that the teaching-material of *Ercsey* had a considerable effect: being held erroneously by his own epoch for the first statistical book written in Hungarian. In other Calvinist colleges the situation was very similar to that, or even worse. For instance *Stephen Rácz,* a professor in the Calvinist College of the little Transdanubian town Pápa, was teaching in the year 1823 the very same Achenwallian statistics as the celebrated German professor some sixty years ago in Göttingen.[10]

VI.

In this politically tormented era the interesting little book of *John Fejes* — a literary gentleman and a Lutheran superintendent of Northern-Hungary — published only one year after the second edition of *Schwartner's* fundamental work, — remained wholly unnoticed.[11] *Fejes,* as a student of *Sonnenfels* and *Schlőzer,* was following the line of thought of *Schlőzer,* and with his intermediary that of *Petty, Graunt* and *Süssmilch.* So he recognized from his studies clearly the emergence of a new science: the demography. However, owing to his sources, his work was much more a product of classical political arithmetics, than that of demography in the up-to-date sense. By giving a complete picture of his district, the county of Kis-Hont with a population of 16.000 souls, — *Fejes* has incorporated in his Latin work his earlier memorandum from the year 1804 to the regent of Hungary, an Austrian archduke. He was proposing in the latter the introduction of obligatory matriculation in the whole country, serving for a base to vital statistics and to the elaboration of population policy, very similar to that of *Hatvani.*

[8] *Magda, P.:* Magyarországnak legújabb statisztikai és geográfiai leírása, Pest, 1819. (The most recent statistical and geographical description of Hungary, — Hungarian text), and especially: A mezei gazdaság philosophiájának szokásai szerint okoskodó és munkálkodó gazda, Sárospatak, 1833. (The countryman, reasoning and labouring according to the principles of agricultural knowledge, — Hungarian text.)

[9] *Ercsey, D.:* Statistica, Debrecen, 1814. (Statistics, — Hungarian text)

[10] *Rácz, I.:* Synopsis Statisticae Statuum Europeorum in genere et Hungariae in specie, Manuscript, Pápa, 1823. (Statistical synopsis of the European states in general and that of Hungary in special, — Latin text)

[11] *Fejes, J.:* De populatione in genere et in Hungaria in specie, Pestini, 1812. (On population in general and in Hungary in special, Latin text)

The demonstration and the ideas advocated by *Fejes* were remaining without any effect. Only *Fáy* mentioned his work in the Hungarian statistical literature as late as 1854.[12] — valuing it negatively enough. In the time of *Fáy*, the elaboration of vital statistics for the whole country was the ordre-de-jour and so it is understandable that he has evaluated the pioneering essay of *Fejes* as too limited in his scope and so he neglected wholly the merits of this little work. The best historiographer of the Hungarian Academy of Sciences in the 1920s, *Gustavus Thirring*, outlined the development of Hungarian statistics only in the Academy-era and so the activity of *Fejes* — mentioned by him — is not valued only mentioned as a forrunner.[13] The evaluation of *Thirring* remains — in spite of this — one of the best analyses of the development of Hungarian statistics from the thirties of the XIXth century on.

VII.

Thirring has laid great stress on the fact, that the Hungarian Academy of Sciences — from its very beginning — was anxious to give an opportunity to the flourishment of statistical science in Hungary. In pursueing this aim the Academy encouraged not only the post-Schwartnerian descriptive statistics — with the new content explained above —, but forwarded the other existing branch of early statistics, i.e. political arithmetics as the more scientific one. I want to focus the attention in this context among the first Hungarian academicians, to the personality and activity of *Stephen Lassu*, too.[14] *Lassu* — without attempting to enrich political arithmetics with new exploits — noticed and stressed however the importance of it. *Thirring* is not even mentioning his name and is not attributing any considerable effect also to the activity of *Stephen Nyiri*, another academician. I am inclined to value the little work of the latter about "The Monetary Foundations of the Industry and Population" more positively.[15] It is true, that *Nyiri* wanted to measure population expansion too mechanically with the matematical apparatus of compound interest, in this I agree with *Thirring* entirely. But he regarded at the same time this problem not only as a mathematical but also as a historical one, — to be solved only on the basis of mortality tables.

From the point of view of the traces of political arithmetics in Hungary it is of far-reaching importance, that *Nyiri* proposed to employ for this more realistical approach an Austrian mortality-table from the year 1829, or a Hungarian one, dating from the year 1817! If this statement of *Nyiri* is correct, the latter must represent the first Hungarian mortality-table, and not that of *Fáy*

[12] *Fáy, A.:* Adatok Magyarország bővebb ismertetésére, Pest, 1854. (Data to learn better Hungary, — Hungarian text)

[13] *Thirring, L.:* Akadémiánk és a hazai statisztika, Budapest, 1927. (Our Academy and the domestic statistics, — Hungarian text)

[14] *Lassu, St.:* A statisztikára való bevezetés és Európának statisztikai, geographiai és históriai rajzolata, Pest, 1828. (An introduction to statistics and the description of Europe from the statistical, geographical and historical point of view, — Hungarian text)

[15] *Nyiri, St.:* Az ipar és népszaporodás pénzalapjai, néhány hitel és adósságtörlő kérdések megfejtésére. Magyar Tudományos Akadémiai Tudománytár, Uj folyam, I. köt., 1837. (The monetary foundations of industry and population expansion, serving to solve some problems in credit and sinking-fund theory, — Hungarian text)

of which I will speak later. Unfortunately, I was not able to find so far any other indications about this table of 1817, — and so this second period of Hungarian political arithmetics — beginning with *Schwartner* and ending with *Nyiri* — remains rather negative.

The contrast is even more than striking, when one is comparing the perfect solution of *Fourier* from 1821 for the mathematical law of the expansion of population, departing thus from the stationary basis, — and the ideas of *Nyiri*. But — for the defence of *Nyiri* and for the whole Hungarian political arithmetics in this second period — it must be remarked, that the performance of *Fourier* filtered also very slowly through into modern bourgeois statistics. It was only better known after the appraisals of the German statisticians *Mohl* and *Knapp* in the seventies of the XIXth century.[16] After all, the judgement seems not unfounded, that in the second period of the Hungarian political arithmetics, the international level was never reached, not even in the coming third period, — to which we must now turn our attention to complete our sketch over the development of political arithmetics in Hungary.

VIII.

To the third period of Hungarian political arithmetics from the forties of the XIXth century on, the "reform-ideology" — fighting for the capitalistic transformation of the country — gave a new impetus, when started in the year 1825 as a by-product of the above mentioned "Reform-diets". We have already stressed the importance of the Hungarian descriptive statistics in furthering the aims of this current, giving to it an important contribution by forming a unified nationalistic public opinion all over the country, — especially through the activity of *Alexius Fényes*. A proper valuation of *Fényes* would be not complete without the research of his activities in the field of political arithmetics. Without the analysis of this question our synthesis would be remain only an incomplete one.[17]

The attention of *Fényes* was more and more drawn in the direction of political arithmetics in the forties of the XIXth century. The turning point was precipitated partly also by the fact, that the enthusiasm and laurels accruing to him, contained some acid criticisms, too. *Fényes* — when receiving the membership and the award of the Hungarian Academy of Sciences for his two great works depicting Hungary statistically.[18] — was at the same time criticised by the secretary of this high institution, by the eminent *Francis Toldy*, for having neglected the more scientific branch of statistics, i.e. political arith-

[16] Compare with *Knapp*, Theorie des Bevölkerungwechsels, op. cit., p. 79.

[17] In my earlier paper on *Fényes* I had given only a revaluation of his ideas from the economic and descriptive statistical point of view: Fényes Elek, a haladó magyar statisztikus és reformer (1807—1876), Acta Univ. Szegediens., Jur. et. Pol., Tom. III. Fasc. 5., Szeged, 1957. (Alexius Fényes, a progressive Hungarian statistician and a pioneer of reform, — Hungarian text with French summary)

[18] *Fényes, A.:* Magyarországnak és a hozzákapcsolt tartományoknak mostani állapotja statisztikai és geográfiai tekintetben, Pest, I—VI. köt., 1836—40. (The present state of Hungary and the legally annexed territories to it from statistical and geographical point of view, — Hungarian text, six volumes) — and: Magyarország statisztikája, Pest, I—III. köt., 1842—43. (The statistics of Hungary, — Hungarian text, three volumes)

metics. The backwardness of spiritual and scientific conditions in Hungary at this time could be not better shown, as by the fact, confirmed also by the researches of *Gustavus Thirring*, that the Hungarian Scientific Academy favorised not the unified bourgeois statistics to descriptive statistics, but political arithmetics, only a contributing part of it.[19] It is understandable, that *Fényes*, being a man of devotion to the nations cause and that of Hungarian statistics, was making a conscious effort to fill this gap.

He was planning a third and more ample statistical description of Hungary and to give in it also a complete picture over the vital statistical conditions for the whole country on the basis of ecclesiastical lists of the churches existing in his time. The greatness of this conception is shown by the first volume of his third "Statistics of Hungary" containing the description of the district of Komárom, published in 1848. Unfortunately, this work was never finished, but *Fényes* saved most of the valuable material by publishing a third finished work in 1851, "The Geographic Dictionary of Hungary". For the geographers and the historians this capital work is an inexhaustible source of data, but — alas — not for the political arithmeticians, as *Fényes* omitted the data of vital statistics. No wonder, that *Fényes* — who has accomplished the task of a whole statistical office by the collection and elaboration of the data of a stationary population on the national level — was forced to abandon another work surpassing the abilities of one single person, i.e. the collection of vital statistics also for the whole country.

IX.

Parallel to *Fényes* in the third period of Hungarian political arithmetics worked *Andrew Fáy* — also a renown fabulist of the epoch. Fáy has followed more special aims than *Fényes*, when he wanted to start capitalistic banking and finance by his participation in the foundation of the "First Domestic-Savings Bank" in 1847, with a department for life-insurance. *Fáy* by pursuing this aim calculated a Hungarian life-table on his own iniciative. He held the opinion, that it would be a dangerous attempt to use the tables of German or Danish life-insurance companies by recalling the example of a company from Hannover, which made a startling fiasco in the Hungarian town Székesfehérvár by adopting without futher specifications German data for Hungarian conditions. The construction of an "exact and authentic" Hungarian life-table was a pressing necessity after this warning example.

So *Fáy* — after having sent 700 circular-letters to the parishes of all religions in the different parts of the country — received vital statistical data nearing to the upper limit of 900.000 souls. This material covered 242.000 death cases from the years 1837—46, i.e. for a whole decade corresponding to 769.000 people. This was the factual base on which *Fáy* constructed his life-table leaning heavily on the Süssmilch-table, corrected by *Baumann*. The use of foreign model was made necessary because of the fact, that his material permitted only for the first three years to calculate yearly death-rates. As for the other generations, the age-structure was not known but only in five or ten years averages. *Fáy* thus recurred to the hypothesis, that the age-structure of his reported Hungarian population must be the same as for the Süssmilch-

[19] Compare with *Thirring*, op. cit., p.

table with minor corrections. After the interpolations and the reduction of his data to 1000, *Fáy* arrived to a result very similar with that of his model, reflecting the conditions of the Northern-German population a hundred years ago.

It is very revealing for the identification of *Fáy's* scientific ideology to read his little brochure published in 1854 entitled "Data serving to a better understanding of Hungary", — containing his mortality-table. In it he was analysing the whole current of political arithmetics and the laws of social-biology and social-development discovered by it, an essential part of it formed by the valuation of former life-tables. He advocated to applicate the findings of political arithmetics to categories of Hungarian towns — bigger or smaller — and to villages. In elaborating his ideas, he was greatly helped by the medical work of *Joseph Pólya,* published in 1837, treating the subject "Medical Topography of the City of Pest", serving as a link with the traditions of the earlier Hungarian political arithmeticians in the field of medical geography.[20]

We have to remark, that the work of *Thirring* was fully aware of the merits and importance of the exploits of *Fáy*[21] valued not even to-day satisfactorily by the historiographers of Hungarian statistics. From our point of view, the work and activity of *Fáy* widely confirms the existence of an outspoken third period of Hungarian political arithmetics, furthering capitalistic finances if only with markedly out-of-date tools. Another argument in this direction is the fact, that the example of *Fáy* was not without effect in the broader circle of Hungarian statisticians.

Among them *Fényes* was the first to imitate *Fáy,* when after the loss of the war of independence he was busy with insurance affairs. In the foreword of one of his pamphlets, published in the late fifties of the century arguing on the necessity of insurance in Hungary, he was mentioning a mortality-table pepared by himself from his own data.[22] This table is conserved only through the care of *Vincent Weninger,* who incorporated it together with that of *Fáy* in his book entitled "Political Arithmetics", published in 1860.

In the pamphlet of *Fényes* and in the work of *Weninger* — unfortunately — there is no indication about the methodology of calculation of this table, but one may suppose with regard to the great factual knowledge inherent in the other works of *Fényes,* — that this table is even standing on a much wider and more solid footing as that of *Fáy* and so perhaps gives a better approximation over the mortality of the epoch. The name of *Weninger* marks however not only the culmination and the end of this third period of Hungarian political arithmetics, but respectively for the whole current in Hungary, representing the transition to scientific statistics in our country.

X.

The first edition of the above mentioned book of *Weninger's* presents from the methodological point of view no novelty, — it is listing the methods of life-tables applied by political arithmeticians and that of life-insurance com-

[20] *Fáy,* op. cit., p. 31.

[21] *Thirring,* op. cit., from p. 14. on

[22] *Fényes, A.:* Szózat a magyar biztosítótársaság érdekében, Pest, 1859. Előszó. (An adress, delivered to create a Hungarian life-insurance company, Foreword, — Hungarian text)

panies, i.e. collected from fragmentary data enriched with different mathematical methods of smoothing and interpolation. But in a paper presented a year later to the Hungarian Academy of Sciences, *Weninger* has developed not only the conventional method of modern bourgeois life-tables based on census, data covering the whole population, but also the possibility of a third method.[23] He argued in this little paper for the construction of a scientifically sound mortality-table, realised theoretically by the inspection of a "sufficiently great number of individuals" from their births to their deaths. This method is in principle the same as that of *Joseph Kőrősy,* who as a director of the Budapest Municipal Statistical Bureau made a concrete attempt to realise a mortality-table for the population of the capital, but the originator of that method was the head of the Bavarian Statistical Office, *Dr. Hermann* in the thirties of the same century. From both, — the original paper of *Weninger* and from the commentaries of *Thirring* — the impression is surging, that there has not existed any direct link between the work of *Hermann* — published in the year 1834 — and that of *Weninger.* The slight theoretical difference between the inspection of a generation — according to the terminology of *Hermann* — and the "inspection of a number of individuals great enough" — according to *Weninger,* speaks also in favour of this supposition. The exposition of *Weninger*'s paper supports, that he strictly meant what he had written, — and if this hypothesis is near to the truth, — it may be another sign of the deep-rooted and long-lasting influence of political arithmetics in Hungary.

XI.

In spite of the fact, that the theoretical and practical workers of Hungarian statistics noticed and furthered the spreading of unified bourgeois statistics in the sixties, this was not identical with the dying-away of the late-political arithmetical influence in Hungary. The opening period of the former may be registered from the publication of *Tormay*'s work over the vital statistics of the cities of Buda and Pest on the basis of the 1857 census of the absolutistic Bach-regime and from that of professor *Konek* from the Pest-University giving a summary from the vital statistics of the whole country on the same basis, also applying the Hermann-table. However the lack of official statistical data issued by a national — and not only the Austrian statistical — administration and the lack of confidence on the side of Hungarian public opinion pressed the central scientific organ of Hungary to find another solution to satisfy public opinion in the pursuit of self-cognition.

The necessities of a national community entering in the stadium of a flourishing capitalism with a prodigious rapidity drove the Hungarian Academy of Sciences into a curious attempt during the years 1861—63 to undertake a census covering the whole population by entirelly scientific means. By imitating the Swedish example of a century earlier, our Academy drafted a questionary

[23] *Weninger, V.:* Politikai számtan, Pest, 1860. (Political arithmetics, — Hungarian text), citation from the second edition with the same title of the year 1869. pp. 425. on)

[24] *Weninger, V.:* Halandósági táblák készítése népszámlálási adatokból, Magyar Tudományos Akadémiai Értesítő, II. köt. 1861—62. (The making of mortality-tables from census data, — Hungarian text)

and sent it to every parish all over the country, to be filled according the matrimonial status of their herds, — the "Statistical Commission" of the Academy being made responsible for the elaboration and publication of the data.[25] The enthusiastic plan failed totally, the Academy and its Statistical Commission being not able to secure the help of the curch-authorities and state-organs as in the case of the Swedish Academy a hundred years earlier in Sweden. This experience played however an essential part in the immediate creation of an independent Hungarian official statistical service.

It was established under the guidance of *Charles Keleti* after the political settlement of the Austrian—Hungarian political relations in 1867, — known as the famous "Ausgleich". Among the greatest protagonists of this idea my be listed *Fényes* as the director of the premature Hungarian Statistical Bureau of 1848—49 and also professor *Konek*. The latter in his statistical manual from the year 1855 has given a paramount picture about the entire European development in the field of official statistical bureaus and that of international statistical congresses. He signalled also the importance of the mathematical trend of contemporary statistics, as a second characteristics of the new development of the unified bourgeois statistics.[26]

I must completely agree with the statement of *Gustavus Thirring* considering the most early scientific self-expression of this unified bourgeois statistics the brief lecture of *Lewis Bitnicz* from 1851 — a not very-well known academician — treating the first appreciation of the doctrines of *Quetelet* and the law of great numbers in Hungary.[27] I want to add to this, that *Bitnicz* used in his critical interpretation a German translation from the works of *Quetelet* and another anonymous work over probability theory and its practical applications, published in Vienna in 1833. The soundness of the criticisms of *Bitnicz* may be controlled by his conclusion, underlining the difference in the manifestation of the law of great numbers in social and in natural sciences. He found that the absoluteness of the said law is not secured in social sciences, — opposite to natural sciences and especially to astronomy —, ecclesiastic and civil authorities and medical science, too, being in the position to alter the social and demographic laws exhibited by *Quetelet*.

XII.

From all our exposition one may draw the conclusion, that Hungarian political arithmetics in the third period moved entirely on the demographic line and neglected — in a way — to furnish economic statistical calculations in the classical political arithmetical manner. No supposition would be more erroneous! *Fényes* deployed an activity in this field of political arithmetics which surpassed that of *Schwartner* or *Magda* considerably. His calculations

[25] *Thirring,* op. cit., pp. 28. on.

[26] *Konek, A.:* Elméleti fejtegetések a statisztika terén, II. rész: A statisztikának legújabb állása közigazgatási, tudományos és irodalmi tekintetből, Pest, 1855. (Theoretical investigations in statistics, Part II.: The latest development in statistics concerning the administrative, the scientific and the literary exploits in this field, — Hungarian text)

[27] *Bitnicz, L.:* A nagy számok törvényéről az ember szellemi nyilatkozataiban, Magyar Tudományos Akadémiai Értesítő, XI. évf., 1851. (On the manifestations of the law of great numbers in the spiritual life of humanity, — Hungarian text)

concerning the balance of trade, the capacity of taxation, Hungary's contribution to support the Hapsburg-Monarchy, etc. —, were all interesting and important exercises in the macro-economic field of political arithmetics and inspired other people to penetrate in this subject.

Similar calculations were worked out by one of his former companions and subordinate in the abortive 1848—49 Statistical Bureau, *John Bárándy*, to obtain the productive capacity of the country for a year.[28] Calculations from the same kind served as a basis to the elaboration of the budget for the revolutionary government in 1848. *Kossuth* as the acting minister of finance was seconded by *Fényes* and his staff, i.e. by the late-political arithmeticians of the third period in the execution of this task resting on national income concepts.[29] In the absolutistic period of 1849—67, *Fényes* once more returned to the short-cut methods of political arithmetical calculations in the field of economic problems because of the lack of reliable, official statistical data. This is clearly shown by one of his last lectures in the Academy in 1867, calculating the contribution of Hungary to the future common costs of the Dualistic-Monarchy in the making, i.e. of that of the political system established with the "Ausgleich".[30] But in this time other economists and economic statisticians were employing more elaborate and more up-to-date methods, when solving similar questions on the basis of uniform bourgeois statistics.

I am arriving now to sum up the third period of Hungarian political arithmetics — stretching from one decade before, to another one after the Hungarian bourgeois revolution and the war of independence (1840—60). This period may be classed as a period of supreme effort of the so-called "reform-generation" to prepare the great historical change from feudalism to capitalism in such a way, as to make up the time lost in the last hundred years. Without contest, the fight for a better future of this generation ran under bad cultural and spiritual conditions, on an obsolete scientific basis, but — in spite of this — they were marching on and gaining ground toward social and scientific progress.

In this fight political arithmetics as a scientific tool substituting the undeveloped Hungarian bourgeois statistics was absolutely indispensable, especially after the collapse of the war of independence, and in the following absolutistic era. Without the existence of it the scientific statistical basis of the Hungarian reformers would had been reduced to the only and more out-of-date branch of earlier statistical thought, i.e. to descriptive statistics. Even this latter had its peculiar merits for the reform-generation because of the lack of a national official statistical service and that of higher mathematical methods of modern, bourgeois statistics — based on the calculus of probability.

In this situation — under the rule of a hostile political regime and under the circumstances of political and cultural isolation — the abandon of the two

[28] *Bárándy, J.:* Über Ungarns Zustände, Pressburg, 1847. (On the present state of Hungary, — German text)

[29] Compare with my little paper: Haladó gondolatok Kossuth egyetemi közgazdaságtani előadásaiban, Jogtudományi Közlöny, 1953. N. 10—11. (Progressive ideas in the university-lectures of Kossuth on economics, — Hungarian text)

[30] *Fényes, A.:* Párhuzam egyfelől a magyar koronai birodalom, másfelől az ausztriai nemzet, lengyel és cseh koronai országok között. Előadás a Magyar Tudományos Akadémián, 1867. (A parallel between the empires of the Hungarian crown and of the states of the Austrian nation, resp. the Polish and Czech crowns, — Hungarian text)

earlier branches of statistics preceding the formation of the new unified bourgeois statistics would have only created a vacuum and made impossible any kind of scientific development in statistics.

XIII.

The scope of our brief synthesis was to give a roughly detailed picture of the problems and development of political arithmetics in Hungary. The many gaps and oversimplifications in the fulfilment of this task may be principally attributed to the extremely condensed character of this essay and also — in a considerable manner — to the fact, that my researches are still going on. So the present wording is reflecting only a first approximation of my thesis. In spite of this, I tried to list all major problems playing a leading part in the making of Hungarian statistics under the time sequence delineated in my study. I think, I was anxious enough to balance my judgement, by allocating the proper place to all principal factors and persons of this development forming an essential part of the economic, social and cultural forces in the great current of history.

With regard to the main conclusions at which I am arriving as the essentials of the present state of my researches, I want to stress the importance and the progressive role of political arithmetics in Hungary, — especially in its first and third periods, marked by the performances of *Hatvani* and in a lesser, but still considerable extent by that of *Fáy* and *Fényes*. Political arithmetical thinking was fighting during all three periods with determination for the capitalistic reform of Hungarian society through understanding of its underlying laws and characteristics, — by furthering in its second period the formation of, and in the third the rapid transition to uniform bourgeois statistics, — especially from the fall of the 1848 revolution to the "Ausgleich" of 1867. It contributed also heavily to the creation of official statistical service in Hungary and was — by its long-outdrawn existence — an important factor in the prodigious rapidity, with which Hungarian official and scientific statistics after 1867 mounted to the level of the more developed Western countries. I am deeply convinced, that the late Hungarian political arithmetics was at least such an important factor in Hungarian scientific history as the long-lasting reign and survival of descriptive statistics and that it contributed considerably to the exigences of Hungarian capitalistic reform.

Every lesson drawn from this synthesis is leading to the final conclusion, that the analysis of Hungarian political arithmetics must be carried futher, not alone for the sake of its progressive role, but also to secure a better understanding of the rise of developed bourgeois statistical era in Hungary. By taking into consideration not only the traditions furnished by its descriptive statistical sources, but also its methodological foundations standing on political arithmetical footing, this end may be surely arrived at.

3.

THE CONTRIBUTION OF NETHERLANDISH THINKING TO THE FORMATION OF STATISTICS AS AN AUTONOMOUS DISCIPLINE

I.

Statistics as an autonomous discipline has a long and very intricate history showing not only several changes of the denomination of this specific kind of scientific knowledge, but variations of its substance and material and those of scientific ideology built on them. This process of scientific formation is not yet finished but is still going on in our days, — as it was clearly demonstrated by a recent contribution in the "Review of the International Institute of Statistics."[1]

The author of the present paper do not want to enter in these problems of modern statistics, but in the contrary, with an up-to-date application of the established results of scientific history, starting from the adopted scientific conception of statistics, he is retracing the initials of statistics as an autonomous discipline. Our scope is to prove the theses, that among the sources of statistics as an autonomous discipline Netherlandish thinking has played a much more important role as reflected in established statistical literature.

From his analysis the author hopes to throw a new light on the formation and true nature of our present conception of statistics. Our demonstration as a first approximation is a very rudimentary one and is based rather on a reinterpretation on the historical evolution of our discipline than on entirely new scientific discoveries in the field of the history of statistical ideas and facts having an influence on them.

II.

As a point of start we want to choose the latest systematic treatise on the history of statistics, that of H. WESTERGAARD dating from the year 1932, a scolarly work in this field. In his introduction[2] the author is distinguishing three theoretically different sources of modern statistics as an autonomous discipline, i.e. descriptive statistics, political arithmetics and the calculus of probability. Later he associates to it — if not explicitly — the activity in the field of official statistics.[3]

WESTERGAARD valued very highly the development of international statistical congresses in the second half of the XIXth century,[4] despite of that, he

[1] KENESSEY, Z.: Some Questions of the Interpretations of Statistics as a Science with Special Regard to Official Statistics, Review of the International Statistical Institute, 1966, No. 2, pp. 156 and furth.

[2] WESTERGAARD, H.: Contributions to the History of Statistics, London, 1932, Introduction, pp. 2 and furth.

[3] Ibidem, pp. 113 and furth.

[4] Ibid., pp. 172 and furth.

has not considered this development as a fifth source of modern statistics, — neither in the field of official statistics, nor in that of systematic scientific collaboration. The latest development, represented by the international statistical activities of international institutions — as the League of Nations, or the United Nations — remained entirely out of the range of WESTERGAARD's work because of the date of its publication.

However, the author of the present paper developed in his university teaching the tenet, that international activity together with official statistical activity has to be counted firmly to the sources of modern statistics,[5] — the demonstration of which is partly furnished by our present paper, — we are anticipating it here only for the sake of integrity of our exposition.

The line of thought of our exposition being based mainly on theoretical and only indirectly on historical arguments, we are choosing to develop our thesis from the analysis of the five sources of modern statistics in their theoretical and historical interdependences and by a reformulation of the main characteristics of their development from our special point of view.

III.

It is a well-known fact that statistics as a new social science was developed by the capitalistic era. As its scientific product, it was derived and condensated from the experiences of capitalistic trade and production and from the structural changes, not only in economic and business life, but also in state administration and in social classes. According to ENGELS, every science is a product of practice[6] and statistics is no exception from it.

The first centers of capitalist development in Europe were found by the most ingenious scholar of this historic process, by MARX, in Upper-Italian towns from the XIV. century on, but as the model state based on this new development, he considered the Netherlands in the XVIIth century,[7] i.e. in the period the first sources of statistics as a new discipline were in formation. No doubt, the Netherlands were the heir of Italian world trade, shifted from the Mediterranean to the whole world. The description of foreign states was so a by-produce of commercial and diplomatic activities, first reappearing in Italy and especially in Venice on antique models as a part of the political literature at the beginning of the XVth century and making a second appearance in the Netherlands. The continuity of this development was fully recognised by one of the best historiographers of our discipline, by V. JOHN.[8]

From our point of view we underline the fact, that the Elzevirian collection of description states was the first to be transformed into business enterprise, with several "scientific contributors" of which the chief editorial and publishing team-work — first realised on the basis of division of labour — contained the essentials of statistical activities, especially in a later phase of

[5] HORVÁTH, R. A.: The History of Statistics and Statistical Ideas, University Scripta, Miskolc Law School, 1948—49. (In Hungarian)

[6] ENGELS, F.: Herrn Eugen Dührings Umwälzung der Wissenschaft, Siebente, unveränderte Auflage, Stuttgart, 1910, p. 26.

[7] MARX, K.: Das Kapital, Erster Band, Fünfte Auflage, Hgg. von ENGELS, F.: Hamburg, 1903. p. 681 and 717, respectively.

[8] JOHN, V.: Geschichte der Statistik, Erster Teil, Von dem Ursprung der Statistik bis auf Quetelet (1835), Stuttgart, 1884, pp. 41 and furth.

development with regard to the growth of material and the appearance of numerical description.

CONRING, — named the "Father of German University Statistics" by ACHENWALL himself —, has understood well the methodical originality to group this new material under systematic and uniform headings, — but missed the point that such a detailed state description was beyond the capacity of an individual scholar. Of Dutch origin, a student of the University of Leyden, where the ELZEVIR brothers were also active and a friend of LAET, he developed succesively in his lectures on politics at the University of Helmstedt from the years 1660 on the new science of "Notitia Rerum Publicarum", or "Staatskunde" — as it was called later in Germany.[9] CONRING worked out a kind of theory concerning the essential characteristics of uniform states' description: territory and population, products, raw and man-made, constitution and administration, finance, land and see-power. The scholastic formula summarising this context is understandable a century prior to KANT's modern philosophy, — as already noticed by JOHN.[10]

CONRING paid in his work one tribute to his predecessors, to the Italians SANSOVINO and BOTERO, but underlined the main influence of the ELZEVIRS and his friend LAET, — and of some other Dutchmen, LUCAS DE LINDA being the most known among them.[11] The system of the "Staatskunde" according to the conception of CONRING incorporated also the constitution of the state, as the influence of HUGO de GROOT, the founder of international law was also a considerable one, — a fact proved by JOHN already.[12] Under these overwhelming Netherlandish influences the introduction of the "Staatskunde" into the curriculum of the university of Helmstedt and later of several other German universities secured it an existence for more than a century without any substantial changes — as rightly pointed out by WESTERGAARD.[13]

New problems arose only when the numerical approximation of states' descprition was made inevitable by the growing influence of political arithmetics and that of the more realistic current of contemporary jurisprudence and especially the new branch of administrative law. Individual scholars without a well-organised business-like staff like that of the ELZEVIR's were not able to collect numerical data for a world statistics in the sense of GATTERER.[14] In the absence of national statistical bureaus this task was impossible to solve even on the national level at this time.

The historical performance of the transformation of descriptive statistics into a modern discipline was first undertaken by the Hungarian statistician M. SCHWARTNER,[15] but only achieved by QUETELET. SCHWARTNER, a pupil of SCHLŐZER, concentrated his efforts to the description of one country only, with intensive use of figures, including of those furnished by political arithmetics.[16] He was underlining already also the importance of the division

[9] Ibid., pp. 68 and furth.
[10] Ibid., pp. 60 and furth.
[11] Ibid., pp. 64 and furth.
[12] Ibid., p. 54.
[13] WESTERGAARD, op. cit., p. 9.
[14] GATTERER, I. E.: Ideal einer allgemeinen Weltstatistik, Göttingen, 1773.
[15] SCHWARTNER, M.: Statistik des Kőnigreichs Ungarn, Ofen, 1798, Zweite, vermehrte und verbesserte Ausgabe, Pesth, 1809—11, Vol. I—II.
[16] Ibid., Second Edition, Vol. I, pp. 89 and furth.

of labour and institutional development in the form of the "Bureau de Statistique" of LUCIEN BONAPARTE.[17] Thus despite the fact, that there existed several earlier works in descriptive statistical literature concentrating on the description of one state only, the turning point was reached and "a bridge between the Staatenkunde and the Political Arithmetics" was built, — we must agree entirely, with WESTERGAARD in this.[18]

IV.

It would be an abrupt idea to contest the fact that political arithmetics was founded in England by the great trio of PETTY, GRAUNT and HALLEY from the same decade on as CONRING undertook his first lectures in Helmstedt. But one of the recent biographies of PETTY, that of STRAUSS, argues that PETTY from this journey in the Netherlands in 1643—45 brought deep impressions concerning the importance of mathematics and empirism both in science and every-day life especially in financial and business calculation.[19]

The famous passage in PETTY's "Political Arithmetick" outlining the methodology of the new discipline suggests that he knew well the confused methodical efforts of descriptive statistics to establish a system in the material, when he writes:[20] "The Method I take to do this, is not yet very usual; for instead of using *only comparative and superlative Words and intellectual Arguments* (my italics), I have taken the course (as a Specimen of the Political Arithmetic I have long aimed at) to express myself in Terms of Number, Weight, or Measure; to use only Arguments of Sense, and to consider only such Cases, as have visible Foundations in Nature; etc." According to WESTERGAARD and according to WESTERGAARD and HULL, these lines were probably written in the years of 1671—76,[21] when the first editions of CONRING's system were already printed by his pupils.[22] — but the core of the critics of PETTY's chief methodological work might have been equally written in the knowledge of the Elsevirian edition, or of the works of DE LINDA, THUANUS, or BARCLAY, — to mention other names from the Elsevirian period.

WESTERGAARD expressing his view that "it was not till the XVIIIth century that Holland reached the position of one of the leading countries with regard to Political Arithmetics",[23] quotes many impressioning Netherlandish examples showing the great influence of GRAUNT's mortality table already in the XVIIth century, owing to the great importance of life annuities and tontines in this country. Especially annuities were playing a considerable role in the highly developed financing methods of public losses and under the pressure of this practical need VAN DAHL, HUDDE and J. DE WITT produced

[17] Ibid., p. 41 and note h) on pp. 42 and furth.

[18] WESTERGAARD, op. cit., p. 13.

[19] STRAUSS, E.: Sir William Petty, London, 1954, p. 26 and furth. — and HORVÁTH, R. A.: Strauss, E.: William Petty, Book-Review in Statisztikai Szemle, 1959, No. 1, p. 109, — with reference to this circumstance.

[20] The Economic Writings of Sir WILLIAM PETTY, Edited by HULL, C. H., Reprints of Economic Classics, New York, 1963, Vol. II, p. 244, — in "Political Arithmetick", Preface.

[21] Ibid., pp. 234 and furth, — and WESTERAARD, op. cit., p. 28.

[22] JOHN, op. cit., p. 69.

[23] WESTERGAARD, op. cit., p. 28.

several mortality tables, — the latter of which "was reflecting better mortality in dependence on age" — according to WESTERGAARD — than GRAUNT's table.[24] The other problem to be solved in this connection, to calculate the value of life annuities, was attacked by Chr. HUYGENS and solved correctly by J. DE WITT in 1671, — i.e. before HALLEY,[25] — a performance reflecting the high standing of political arithmetics in Holland in the XVIIth century.

It was not until half a century later that the material of life annuities was used to estimate the entire population of the provinces of Holland and Westfriesland. This task was performed by KERSSEBOOM on the base of his mortality table. That was the reason, KNAPP considered him as "the most fertile, genial and original author in this field"[26] — elevating the theoretical standing of political arithmetics again from the rank of life insurance calculations into the orbit of population theory, — following thus GRAUNT's and PETTY's steps.[27]

Despite his severe methodological criticisms in the analysis of KERSSEBOOM's work, WESTERGAARD maintains that he "justly deserves his reputation as one of the most prominent statisticians of the XVIIIth century".[28] With regard to the methodological insight of KERSSEBOOM, we agree rather with KNAPP than with WESTERGAARD, — who seems to favour a countryman of KERSSEBOOM against him, i.e. STRUYCK.[29] Further, — if we agree with KNAPP that KERSSEBOOM and not HALLEY was the first to simplify the calculation of mortality tables under the hypothesis that the sum of deceased belonged to the same generation —,[30] the whole problematics of Süssmilchian mortality tables — with the intermediary of WARGENTIN — go historically back to KERSSEBOOM.

The work of SÜSSMILCH — according to my own conclusions[31] — was the first systematic attempt — even before ACHENWALL — to present statistics in the form of demography as an autonomous discipline. SÜSSMILCH has given in his "Divine Order" broad publicity on a European scale to the rich material from Netherlandish sources. How deep the interest in Holland in these matters went, is clearly shown by the fact that it was only in this country that an integral translation of the Süssmilchian work has appeared in 1770—72.[32] If one is ready to consider the "Divine Order" as a first attempt to reshape older form of statistics — and that of SCHWARTNER's another one —, the period marked by both of them may be regarded as the end of political arithmetics in the stricter sense. This argument could be reinforced by another one, namely SÜSSMILCH has already advocated the introduction of official

[24] Ibid., p. 27.

[25] Ibid., pp. 27 and furth, and pp. 34 and furth.

[26] KNAPP, G. F.: Theorie des Bevölkerungs-Wechsels, Braunschweig, 1874, p. 67, — as follows: „... so nehme ich keinen Anstand ihn für den fruchtbarsten, scharfsinnigsten und eigenthümlichsten Schriftsteller auf unserm Gebiet zu erklaeren..."

[27] Ibid., p. 68.

[28] WESTERGAARD, op. cit., p. 66.

[29] Ibid., pp. 63 and furth.

[30] KNAPP, op. cit., p. 65.

[31] HORVÁTH, R. A.: "L'Ordre Divin" de Süssmilch, Population, 1962, No., pp. 280 and furth.

[32] Ibid., p. 268 note (1), — with reference to SÜSSMILCH, J. P.: De goddelyke orde, herschende in de veränderungen van het menschlyk geschlacht, etc., Amsterdam, 1770—72, Vol. I—IV.

statistics on the base of vital statistics, while SCHWARTNER has laid the emphasis on population censuses complemented by vital statistical material, i.e. they stressed the importance of regular numerical documentation embracing the whole country, — a need recognised the first time completely by KERSSE-BOOM.

However, the transition from statistical observations to mathematically conform laws was a very difficult one and its unsettled character was one of the main reasons of "stagnation of political arithmetics"[33] during the whole XVIIIth century. In this period the questions of methodology and especially the progress of the theory of probability became the crucial field of further development in statistics as a scientific discipline.

V.

WESTERGAARD has given a fairly correct picture of the development of probabilistic methods with relevance to statistics in the Xth Chapter of his standard work.[34] We agree completely with his statement, that "Investigations in the Calculus of Probability were mostly of purely abstract nature... they promoted pure mathematics, but it took a very long time before the calculus of probability came into closer contact with statistics"[35] and here is the "curious difference" between SÜSSMILCH and DE MOIVRE located,[36] if we are rightly interpreting his exposition. WESTERGAARD applies this statement even to QUETELET, who discussed the same problem in two of his tracts, "but strangely did not apply the theory much in practice."[37]

As the development of probability theory and the formation of statistics as an autonomous science were not running historically parallelly, we are attributing at the beginnings a greater importance in this process to the "Netherlandish-line" and not to the "French" one. It is a well-known fact, that JACOB BERNOULLI — himself of Netherlandish origin —[38] based overwhelmingly his theoretical investigations on HUYGENS' essay instead of those of PASCAL and FERMAT, by incorporating it literally in his "Ars conjectandi".[39] Owing to the fact that his mathematical methods were laborious and his masterpiece unfinished, and further that DE MOIVRE's similar discoveries passed completely unnoticed in continental Europe, — the conversion of the BERNOULLI-theorem was applied to political arithmetics through the philosophical approximation of contemporaneous logics.

Rediscovering and analysing the activity of the XVIIIth century Hungarian political arithmetician HATVANI,[40] I pointed out in my monography the fact, that BERNOULLI's thesis — "to find from numberless observations the

[33] WESTERGAARD, op. cit. Chapter V, pp. 44 and furth.
[34] Ibid., pp. 100 and furth.
[35] Ibid., p. 101.
[36] Ibid., p. 105.
[37] Ibid., p. 140, — with reference to his "Recherches Statistiques" from 1844 and "Lettres sur la Théorie des Probabilités" from Paris, 1846.
[38] WALKER, H. S.: Studies in the History of Statistical Method, Baltimore, 1931, pp. and furth.
[39] WESTERGAARD, op. cit., on p. 103 also refers to this fact.
[40] HORVÁTH, R. A.: Professor Stephen Hatvani (1718—86) and the Origins of Statistics in Hungary, Budapest, 1963. (In Hung., with French summary)

ratio of the events to converge to a determinate quantity", as DE MOIVRE put it[41] — was applied to statistical reasoning through the intermediary of the Dutch philosopher and mathematician W. J. S.' GRAVESANDE.[42] His very popular if even not highly scientifical treatise furnished a "bridge" through the way of inductive logics by "ratiocination" — in HUYGENS wording —[43] to establish a "Divine Order" in the Süssmilchian sense, or a physical and moral one, i.e. a social order in the Queteletian version.

I think to have also documented the fact, that both the first and second editions of SÜSSMILCH's work and the works of GESSNER — a famous Swiss political arithmetician — and of HATVANI made explicit use of the treatise of S'GRAVESANDE.[44] The fact that the latter was influenced strongly by KERSSEBOOM, was already demonstrated by KNAPP,[45] — so we do not enter into this question. Equally it seems to be superfluous to analyse the contributions of QUETELET in this field. We content ourselves with stressing the point that the above quoted passage of WESTERGAARD concerning QUETELET seems to be in perfect harmony with our present line of thought, too.

For the rest of our paper, it is more promising to make two brief remarks on the development of official statistics and on the beginnings of international statistical activity as complementary sources of statistics in our interpretation.

VI.

The first remark concerning the development of official statistics is in connection with the decisive influence of QUETELET. Through it Netherlandish thinking played a considerable role in the shaping of official statistical services in Europe, especially from the year of 1841 on, when QUETELET became the president of the Statistical Central Commission, the govering body of official statistics in Belgium.[46] It is true, the first model office was developed in France in 1800 as referred to, i.e. in one of the greatest and most centralised countries of Europe, but its capital weakness may be found in the lack of businesslike organisation, its collaborators working individually, without division and unification of labour in the modern sense, — that was my conclusion of a detailed field—study of this special question in 1947.[47] Official statistical

[41] WESTERGAARD, op. cit., p. 105, — with reference to DE MOIVRE, A.: The Doctrine of Chances, Second Ed., London, 1738.

[42] S'GRAVESANDRE, W. J.: Introductio ad Philosophiam, Metaphisicam et Logicam Continens, Leydae, 1736. Ed. Altera: Ibid., 1737, Sec. Ed.: Venice, 1748, Third. Ed.: Leydae, 1756, — The author was a professor for mathematics and philosophy at the University of Leyden from 1717 till to his death in 1742.

[43] HUYGENS, Chr.: De Ratiociniis de Ludo Aleae, 1657.

[44] HORVÁTH, as under (40), Part III: "Hatvani's Political Arithmetical teachings and their sources". Chapter II, pp. 109 and furth.

[45] KNAPP, op. cit., pp. 60 and furth., and especially note (2) on p. 60.

[46] JULIN, A.: The History and Development of Statistics in Belgium, The History of Statistics, Their Development and Progress in Many Countries, Collected and Edited by KOREN, J., New York, 1918, pp. 129 and furth.

[47] HORVÁTH, R.: The History of Official Statistical Service in France, Magyar Statisztikai Szemle, 1947, No. 10—12, pp. 469 and furth. (in Hung. with French summary)

organisation was thus lagging behind the capitalistic spirit of the "Code Napoléon" and that of the reorganisation of French public administration.

Contrary to that, the Statistical Bureau, established in 1826 in the Hague, prospered fairly well, under the guidance of SMITS and QUETELET, profiting from the introduction of decennial censuses from 1828 on. From the time of the separation of Belgium and Holland, i.e. from 1831 on, the two leading spirits stayed with Belgium. From 1841 on QUETELET by summarising the experiences of two modern censuses and institutional development created soon a model service codified in the form of the 1847-statute, rightly recommended later by the second International Statistical Congress in Paris, in 1855, to other states to follow.[48]

The importance of censuses to master statistical methods and techniques has had a preponderant effect on the development on institutional and legal organisation of official statistical services, — as economic statistics was lagging behind from this point of view, — an argument already elaborated in a little essay by the author of the present paper some years ago.[49] WESTERGAARD recognised this — if not explicitly —, when he spoke about the expansion of official statistics all over the world by the end of the XIXth century.[50]

Owing to several difficulties,[51] not only to the remarkable performance of QUETELET, the center of gravity was located after the separation of Belgium and Holland in the former territory.

Our second remark as regards the development of international statistical activity, concerns the merits of QUETELET, equally outstanding in this field. The so-called "Congress Period",[52] initiated by him, was promoting at the same time on the technical and theoretical scale the diffusion of modern statistics, — international official and scientific cooperation included. No wonder, it was under his impact, the first International Statistical Congress was held at Brussels in 1853 and the seventh one at the Hague, in 1869, where the plan of a "Statistique Internationale de l'Europe", was also prepared as a modern version of "Elsevirian states' descriptions".[53]

As this form of international statistical cooperation was outlived, it gave way to a new and more scientific institution, to the International Statistical Institute, in 1885, a free scientific association not hindered by problems of great-power politics.[54] The magnanimity of the contemporaneous Dutch government and that of the city of the Hague, assisted with other Dutch bodies, helped the highest international academic institution of statistics to found a permanent office in the Hague on the eve of World War I, in 1913,[55] an event not entirely fortuitous, when looking back at our previous analysis and its conclusions.

[48] WESTERGAARD, op. cit., p. 175, — with quotation of the recommandation of the Paris Congress.

[49] HORVÁTH, R.: The importance of censuses in statistical and legal development, Jogtudományi Közlöny, 19, No. (Hung. text)

[50] WESTERGAARD, op. cit., pp. 236 and furth.

[51] VERRIJN STUART, C. A.: The History and Development of Statistics in the Netherlands, The History of Statistics, etc., as above under (46), pp. 433 and furth.

[52] WESTERGAARD, op. cit., Chapter XIV, pp. 172 and furth.

[53] Ibid., p. 180.

[54] NIXON, J. W.: A History of the International Statistical Institute 1885—1960, The Hague, 1960, pp. 9 and furth.

[55] Ibid., p. 25.

VII.

Summing up our investigations in this special field of analysis of a great complexity, we hope to have demonstrated that the study of scientific history may furnish not only new facts, or lay a new emphasis on known facts with a different result, as conclusion, but on the basis of this piecemeal-work one can progress to a reinterpretation of the whole historical process and to arrive to a new synthesis. Such an intellectual effort may be not without consequences in laying bare the nature, scope and significance of up-to-date statistics with its ever changing facets.

4.

300 YEARS ANNIVERSARY OF THE BIRTH OF DE MOIVRE

In 1967 it was 300 years ago, that in the little town of Vitry in Champagne, France, on the 26th May in 1667 ABRAHAM DE MOIVRE, the great mathematician was born.[1]

I.

The mathematical activity of this genial man is evaluated by scientific history as that of the greatest pioneers of probability theory before LAPLACE[2] and the most recent contributions are estimating, that his performance is even equal to that of LAPLACE's.[3] Being equally well versed in the special field of probability theory and in the theory of annuities, he contributed also considerably to the development of an important branch of applied mathematics, that of the actuarial science.

However, from the point of view of scientific history his activity on the first mentioned terrain of probability theory proper has exercised a more lasting influence, as the fundaments laid down by him played an important role in the making of statistics in the form as represented by QUETELET around the middle of the XIXth century.

It is a well known fact that the impact of probability theory on statistics was even more impressive during the last hundred years than in the Queteletian era of formation. This trend was demonstrated by the rise of the "school of mathematical statistics" in the 70ies of the XIXth century and once again — if I dare say — more radically in the up-to-date currents, whose final scope is a liquidation of conventional statistics as an autonomous discipline and its substitution by probability theory as a universal methodology for every quantified branch of science, whether social, or natural.[4]

These contemporary scientific currents may be considered as the culmination of those endeavours in early scientific thought of enlightened philosophy,

[1] WALKER, H. M.: Abraham de Moivre, *Scripta mathematica,* Vo. II. Nr. 4. 1934, pp. 316 and furth., —"—: Abraham de Moivre, Annex to the photographic reprint "DE MOIVRE, A.: The Doctrine of Chances, 3rd Edition, 1756", New York, 1967.

[2] TODHUNTER, I.: History of Mathematical Theory of Probability from the Time of Pascal to that of Laplace, Reprint, New York, 1949, — the original edition with the same title, Cambridge and London, 1865.

[3] ARCHIBALD, R. C.: Outline of the History of Mathematics, 6th Edition, *American Mathematical Monthly,* Vol. 56., 1949, No. 1.

[4] KENESSEY, Z.: Some Questions of the Interpretations of Statistics as a Science with special regard to Official Statistics, *Review of the International Statistical Institute,* 1966, No. 2.

which had seen in mathematics the unique and "royal" way of scientific cognition and in the mathematical formulation of "laws" true science itself.

Hungarian statistics has two special reasons to commemorate the anniversary of DE MOIVRE and his brilliant scientific exploits. First, one of his important scientific publications, the "Mensura Sortis" published in 1711 was with marked influence on Professor STEPHEN HATVANI in the Old Debrecen College as regards statistical methodology, — documentated recently by the author.[5] HATVANI was led partly by this work to statistical applications of probability theory on a high scientific level, surpassing — partly — even contemporary Political Arithmetical thought.

Secondly, DE MOIVRE's name is connected with the revival of mathematical statistical thought in the XXieth century, in which the Hungarian CHARLES JORDAN played also a distinguished role, under whose influence a school of Hungarian probabilists is nowadays in the making.[6]

These special reasons and the problematic character of the relation of statistics in the broader sense and that of probability theory and mathematical statistics in the narrower meaning give an opportunity to reconsider on hand of DE MOIVRE's anniversary those fundamental problems of statistics, which are connected with his life and his scientific activities.

II.

The life and scientific activity of DE MOIVRE are almost completely known thanks to the research-work done by HELEN S. WALKER in the 30ies of our century.[7] There is not much left to clear as to the main points.

DE MOIVRE was born of a family of bourgeois origin, his father gave an outstanding education to his son. The young man started his studies with private tutors and later entered into the School of the Fathers of Christian Faith in Vitry, into a counterreformatory teaching order, — despite the fact the DE MOIVRE—family was Huguenot. With 11 years the extraordinary talented boy was admitted to the Protestant University at Sedan, where he absolved his studies in classical philology in the house and under the guidance of Professor DU RONDEL. The influence of his lectures in mathematics was decisive during these studies, completed by those of the "Arithmetics" of LE GENDRE and the "Elements of Algebra" of PRESTET.

In 1681 the University of Sedan was abolished as a consequence of the persecution of Huguenots and thus DE MOIVRE was forced to pursue his

[5] HORVÁTH, R.: Professor Stephen Hatvani (1718—1786) and the Origins of Scientific Statistics in Hungary, Budapest, 1963, pp. 323 (In Hungarian with French and Russian Summaries).

[6] RÉNYI, A.: Probability Theory, University Textbook, Budapest, 1955, Annex: A Short Outline of the History of Probability Theory in Hungary, pp. 689 and further.

[7] GRANDJEAN DE FOUCHY: Eloge de Moivre, Histoire de l'Académie Royale des Sciences 1754, — MATY, M.: Mémoire sur la Vie de M. de Moivre, La Haye 1760. — HAAG, E.: La France Protestante, 1757, Vol. VII. under "Moivre". — WOLLENSCHLAGER, K.: Der mathematische Briefwechsel zwischen J. Bernoulli und Abraham de Moivre, *Verhandlungen der Naturforschender Gesellschaft in Basel*, Vol. XLIII, Basel, 1933. — All these sources are quoted by WALKER, op. cit. under 1, pp. 352 and furth., — WALKER, H. M.: Studies in the History of Statistical Method, Baltimore, 1929.

higher studies first when he was in Saumur and then in Paris. In these years he studied mainly philosophy, mathematics, geometry and physics and already in Saumur he has known the famous work "De Ludo Aleae" of the renowned Dutch mathematician, CHRISTIAN HUYGENS, published in 1657, inspiring also the work of JAMES BERNOULLI, the most genial representant of contemporary probability theory.

In Paris DE MOIVRE made further steps in this direction, being a student in mathematics and physics of Professor JACQUES OZANAM, a teacher of world-wide fame in this time, — but he studied also the works of HENRION, — especially "Trigonometry" and "Applied Geometry", — besides the classic works in this field.

His education is thus in a vivid contrast to that of the other great statistical genius of the epoch, i.e. to the education of WILLIAM PETTY, as regards their mathematical training. That of DE MOIVRE's was a maximal one against the mathematical formation of PETTY, the latter representing the minimum, indispensable to enter into statistical speculations.[8]

The revocation of the Edict of Nantes in 1685 and the outlawing of the Huguenots in France as a historical event of general importance was deeply influencing also the career of DE MOIVRE. Under circumstances not yet cleared he was imprisoned as a Huguenot in the St. Martins Abbey in Paris and he was liberated only in April 1688. After this he immediately emigrated to England in his 21th and passed all his life — 66 years more — in London. There he died on the 27th November 1754.

His scientific career started in London, here he gained a world-wide reputation as a mathematician, but also here he learnt everyday problems of gaining his life and the vanishing hope to obtain a university-chair and with it not only scientific, but also financial establishment.

At the beginning of his emigration DE MOIVRE worked mostly as a private tutor. As his fame rose, he secured an income also from solving fashionable problems in games of hazard, by expertizing in theoretical problems and by writing scientific essays offered to wealthy aristocrats. During the early rise of his fame played not only erudition and geniality a considerable part, but also his straight character and his extraordinary modesty, — acquiring him the friendship of the most outstanding scientists of England and later on — by correspondence — of all the other European experts, who played a role in scientific mathematical development of his days.

His first essay was presented in the Royal Society by EDMUND HALLEY in 1695, with whom he was connected in sincere friendship during more than 25 years. It was HALLEY's influence, which inspired him to start his researches in the problems of annuities on lives. Another friendship of great importance — perhaps the most valuable not only from scientific, but also from practical point of view — connected him to ISAAC NEWTON, the scientific giant of the epoch.[9] In DE MOIVRE's writings this is mentioned first in 1705, — but probably the connection was even older than that, as the first essay presented by HALLEY gave the development of one of NEWTON's theories,

[8] STRAUSS, E.: Sir William Petty, Portrait of a Genius, London, 1954.

[9] EISENHART, CH.—BIRNBAUM, A.: Anniversaries in 1966—67 of Interest of Statisticians, Part II, Tercennials of Arbuthnot and de Moivre, *The American Statistician,* 1967, No. 3, pp. 22 and furth.

— the theory of "fluxions".[10] Their friendship became almost legendary and contemporary sources mention the old NEWTON to say when consulted over problems of mathematical theory to go to DE MOIVRE, who could give a more comprehensive answer on the subject.

DE MOIVRE was also attached by ties of friendship to JAMES STIRLING, the inventor of the Stirling's theorem, — to JONES, the real discoverer of the Ludolf-parameter, — to SIMPSON and many other contemporary scientists with fame. By correspondence he established contacts with JOHN BERNOULLI, brother of JAMES BERNOULLI, and with NICOLAS BERNOULLI, a nephew of them, and he also met once the latter during his short visit in London. He was in contact also with PIERRE REMOND MONTMORT and JOHN ARBUTHNOT, and with the latter he participated in the same Commission of the Royal Society created to find out the priority in the scientific discovery of infinitesimal calculus between NEWTON and LEIBNIZ. Both of them were standing so high in esteem in DE MOIVRE's thought, that he did not pronounce in this question.

The extraordinary spell of his individual character is also shown by the fact, that he acquired many of his friends after engaging himself in bitter and personal scientific discussion with them. That was the case with SIMPSON and MONTMORT, but also with several others, not mentioned here, — the only exception being the outstanding Scottish physician and mathematician GEORGE CHEYNE. However, in the irreconciliable behaviour of the latter played besides the extraordinary bitter tone of polemics also the religious antimony a major part, — CHEYNE being a Catholic.

III.

In this favourable scientific environment — which was englobing almost the whole spectrum of European mathematical science, not only the English, either by personal contacts, or by correspondence — the scientific activity of DE MOIVRE began to rise very fastly.

His first essay was succeeded by 15 smaller ones until 1711,[11] — i.e. to the publication of his first major work, the "Mensura Sortis".[12] This essay was

[10] DE MOIVRE, A.: Speciminine quadam illustria doctrinae fluxionum sine exempla quibus methodi istius usus et praestancia in solvendis problematis geometicis elucidantur, ex epistola peritissimi mathematici D. Abr. de Moivre desumpt, Philosophical Transactions, 1695.

[11] DE MOIVRE, A.: A method of Raising an infinite Multinomial to any given power or extracting any given root of the same, Philosophical Transactions, 1697.

[12] DE MOIVRE, A.: De Mensura Sortis, seu Probabilitate Eventum in Ludis a Casu Fortuito Pendentibus, Philosophical Transactions, 1711. — It is interesting to note, that the process of growth of the volume of the treatise may be measured also from the bibliographic data. The first Latin-version of 1711 had 52 pages of quarto, the first English-version of 1718 already 175 pages, the second one of 1738, 258, without the preface in both of them on 14 pages (I—XIV.). The preface of the third English-version was only 12 pages, but its volume 348, owing to the incorporation of the treatise of "Annuities on Lives". Without the latter the volume of the third English-edition with its 259 pages remained nearly unchanged. WALKER in his work under 1, pp. 360—61, mentions twice the date of publication of the first English-version as 1717. This may be attributed to the fact that she refers to the preface of it, which was signed as 1717 and not 1718. It is also interesting, that EISENHART—BIRNBAUM, op. cit. as under 9 on p. 92 are speaking — with refe-

printed in full by the Royal Society, — as produced by one of its members, — DE MOIVRE being elected already on the account of his second paper in 1697 into this learned society. DE MOIVRE revised and broadened the Latin version of this work and published it in 1718 in English under the title "The Doctrine of Chances". A second and further enlarged English edition of it appeared in 1738, and a third one in 1756 as a posthumous edition, — all of them in London.

This work is considered even today as his chief contribution. (In 1968 the first English edition had thus a 250-years anniversary, and the second one a 230-years jubilee, — giving and opportunity to the elaboration of the present study.)

From the point of view of statistical discipline it is important to mention that DE MOIVRE has incorporated in the second and third English editions of his main-work a translation of his short work known as "Aproximatio".[13] This Approximation is containing his most important scientific discovery as regards probability and the convergency of the binominal distribution to it in the case $p=q=1/2$. The demonstration of this theorem and its application to statistical masses was known in scientific literature for long as the "conversion of the Bernoulli-theorem". This paper of DE MOIVRE ascends to the early 1720ies,[14] but he published it first only in 1733, — as an "Appendix" to his work entitled "Miscellanea Analitica" published earlier, in 1730.[15] The paramount importance of this discovery was completely missed by his contemporaries, — a circumstance also shown by the fact, that DE MOIVRE was elected member of the Prussian Academy of Sciences in Berlin in 1735 on the ground of the original paper dating from 1730 and not because of the "Appendix".

It has also some importance to mention, that DE MOIVRE made special efforts to incorporate in his "Doctrine of Chances" the second main field of his scientific activity, the research done in the problems of annuities on lives. His work on this subject "A Treatise of Annuities on Lives" appeared already in 1724 in London and was so well received by the public, that it was followed

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rence to the work of H. L. SEAL — of two main work of de Moivre, but the author of the present paper speaks only of one, as the "Treatise of Annuities" was incorporated into the "Doctrine of Chances". — The work of SEAL was under press by the time of the reference made by EISENHART—BIRNBAUM for the International Encyclopedia of the Social Sciences, to be published in New York, according to 9, p. 20, note 37.

[13] DE MOIVRE, A.: Approximatio ad Summam Terminorum Binomii $(a+b)^n$ in Seriem Expansi, Private Edition, London, 1733. This Annex seems to be attached only to some copies of the "Miscellanea Analytica", sold in 1733, hence its special rarity —, according to WALKER, as under 7, p. 13 and furth.

[14] — This Edition was first discovered by Karl PEARSON who published his findings under the title: Historical Note on the Normal Curve of Errors, *Biometrika*, Vol. XVII. 1924, pp. 402 and furth. A facsimile edition was produced with notes by WALKER in the work of SMITH, D. E.: A Source Book in Mathematics, New York, 1929, Vol. I—II, — and she commented it in her treatise as under 7, pp. 13. and furth., under the title: A Method of Approximating the Sum of the terms of the Binomial $(a+b)^m$ expanded into a Series from whence are deduced some practical rules to estimate the Degree of Assent which is to be given to Experiments.

[15] DE MOIVRE, A.: Miscellanea Analytica de Seriebus et Quadraturis..., London, 1730.

till 1752 by 3 successive editions.[16] Despite of this success DE MOIVRE gave instructions to his friends preparing a full publication of his life-work to insert in it the full text of the work on annuities and by this way he secured its integration in one volume.

This whole great scientific effort was absolved under even harder financial conditions. In the last period the visiting of his pupils grew to an insupportable burden to the ageing scientist, as London became too big a city for pedestrians. He lost enormously his free time by walking from one disciple to another and this loss hindered him greatly in scientific production. The loss of physical strength was only to make good by increasing the time for sleeping. This circumstance gave rise to the circulation of the apocryphal story, that he calculated the need of sleep-increase as a daily average of 15 seconds and arrived to the full 24 hours at his supposed 87th life-year, — i.e. his real death-year. However, it is a historical fact that he extended in his latest years his sleeping hours over 20 and his death occured after 8 days of overall-sleeping

It seems also probable that the whole problem of duration of life was taken over by mathematicians from the inventory of current political arithmetical thought, this kind of literature being very popular before contemporary readers. This was reflected in the work of the Swiss Professor GESSNER from 1748[17] and even more in detail in the book of Professor HATVANI in Hungary from 1757. The latter gave a good sample from the current problems of contemporary Political Arithmetics and among them on the problem of time-balance of human life.

It is also not without interest that DE MOIVRE never set foot on French territory after his emigration and never published any works in French. His whole scientific production was thus incorporated into contemporary English science. This does not mean that he had not established contacts, — scientific and friendly —, with French scientists and what is more important, some months before his death, in 1754, he was also elected member of the "Institut de France", i.e. the French Academy of Sciences.

It is, however, also characteristic that in the contemporary and later French scientific literature he was always referred to as "MOIVRE", — despite the fact that our author signed all his contributions very consequently as "DE MOIVRE", — even if the orthography is showing some inconsequences.

IV.

The correct exposition of DE MOIVRE's scientific activity is much more problematic from the point of view of scientific history and epistemology than the presentation of his career and his chief publications.

Both the exposition of his scientific exploits and especially its evaluation

[16] DE MOIVRE, A.: A Treatise of Annunities on Lives, London, 1724, 2nd edition, ibid., 1743, 3rd ed. ibid., 1750, 4th ed. ibid., 1752. Another and a 4th edition of the "Doctrine of Chances" in Italian, under the title: La Dottrina degli Azardi, applicata ai Problemi della Probabilita della Vita, della pensioni, Vitalizie, Reversione, Tontine, etc. Milano, 1776, — has reproduced only the "Treatise of Annuities", with several additions from contemporaneous Italian authors.

[17] GESSNER, J.: De termino Vitae, Tiguri, 1748. — See also HORVÁTH, op. cit. as under 5, p. 292.

were constantly changing during different periods. Thus it is no wonder, that for a long time his contributions were not at all considered in the formation and development of statistics as an autonomous discipline. The significance of probability theory in the rise of scientific statistics was recognised first under the impact of the mathematical-statistical school and by its revival in our century, but among the greatest early representants of probability theory, — besides HUYGENS, MONTMORT and JAMES BERNOULLI —, DE MOIVRE was the last, whose merits came to his own.

The radical change came only with Professor KARL PEARSON and his discovery of the first version in Latin of the "Approximatio" in 1924 and his subsequent evaluation of this document from the point of view of modern statistical thought. This served as a base to the reconsideration of DE MOIVRE's life-work and its incorporation into the history of statistics, from the methodological side by WALKER, and on a broader line, by WESTERGAARD, at the beginning of the 1920-ies and the 1930-ies, respectively.[18]

The question as a whole was not brought then to a rest. The most recent research work in the history of mathematical statistics englightened many points not without interest for a proper scientific evaluation of DE MOIVRE. Thus, in the latest syntheses many new features have appeared and our present paper wants to be just one in this series by reconsidering this problematic question.

Our starting point is, that in the mathematical foundations of probability theory the theory of games of hazard played the same key-role as in our century the modern game theory in the development in cybernetics.[19]

Recently the manual of WESTERGAARD assessed the beginnings of the theory of the games of hazard from the point of view of statistical development. He stressed the point that already in the XVIth century the problem was stated by the Italian mathematicians CARDAN and GALILEO, but the main impetus on probability theory was given a century later, by the contributions of PASCAL, FERMAT and especially by those of HUYGENS. The same is true of JAMES BERNOULLI, having completely incorporated the work of HUYGENS in his pioneer-work, the "Ars Conjectandi", published posthumously in 1713.

At this point we wish to underline the fact that the treatise of BERNOULLI was not at DE MOIVRE's disposal, when elaborating and publishing his first essay on probability, the "Mensura Sortis". In this time he could only use the more rudimentary work of MONMORT on the same subject, published earlier, in 1708.[20]

In his first important contribution to probability DE MOIVRE based his exposition wholly on the ideas of HUYGENS and he attributed not much importance to that of MONMORT. This omission gave rise to the sharp pole-

[18] WESTERGAARD, H.: Contributions to the History of Statistics, London, 1932. In another essay from the late 1940ies entitled. "The Development of Statistics in France with special regard to Hungary", *Acta Universitatis Szegediensis,* Juridica et Politica, Tom. XIV., Fasc. 4., Szeged, 1967, — the author of the present paper referred to the exploits of DE MOIVRE in close connection with the development of French probability theory.

[19] NEUMANN, J.: To the theory of Social Games, Selected Lectures and Essays, Budapest, 1968. (In Hungarian).

[20] MONTMORT, R. P.: Essai d'Analyse sur les Jeux de Hasards, 1708, — 2nd edition 1714.

mics between MONMORT and DE MOIVRE, which ended in a lasting friendship. The good faith of DE MOIVRE may be documented by his preface of 1711, — where he is explaining that this paper of his was outlined "some seven years earlier", i.e. about the year 1705. So it is understandable that DE MOIVRE judged as superflouous to refer to the ideas of MONMORT, even much so, as his mathematical apparatus was much more developed than that of MONMORT, or even that of BERNOULLI in the exposition of the theory of card-plays and games of hazard in general.

The treatise of 1711 may be considered as a gamblers-manual, giving an outline of their theoretical problems from the mathematical point of view. This fundamental treatise was enlarged and implemented by DE MOIVRE later in the subsequent English editions of 1718, 1738 and its posthumous last edition of 1756. DE MOIVRE has shown much ingenuity in the use of infinite series and their development and in the calculus as discovered by NEWTON,[21] arriving at last to the problem of POISSON — and binomial distributions. A XXieth century scholar, ETHEL M. NEWBOLD, in her 1927-contribution stressed the point that DE MOIVRE made use already in the first English version of his "Doctrine of Chances" to locate the terms of binomial distribution of the limiting distribution of POISSON, — according to XXieth century terminology.[22] Another up-to-date research worker, FRANK HAIGHT, agreed fully with the interpretation of NEWBOLD,[23] and so, another important side of DE MOIVRE's exploit emerged. These contributions were not without further consequences as regards scientific history of statistics, focusing on a problem omitted by former research. That is the reason, that our paper reproduces this famous passage in English original in a footnote.[24]

[21] According to the historical note of the *Encyclopaedia Britannica*, Chicago—London—Toronto—Geneva—Sidney—Tokyo, 1965. Vol. 3, N. 629, under "Binomial Theorem" — it appears first in 1676 in two letters NEWTON's to OLDENBURG, — if we exclude such forms in lower powers as $(a+b)^2$ and $(a+b)^4$, or the "arithmetical triangle" of PASCAL. A demonstration of this theorem was first given by JAMES BERNOULLI in his "Ars Conjectandi" but without strict mathematical development. This was absolved with general validity by the Norwegian mathematican N. H. ABEL in 1826.

[22] NEWBOLD, E. M.: Practical Applications of the Statistics of Repeated Events, particularly to Industrial Accidents, *Journal of the Royal Statistical Society,* Vol. 90, 1927, No. 3, pp. 487 and furth. The discussion of the article ibid., under pp. 545 and furth.

[23] HAIGHT, F.: A Handbook of the Poisson-Distribution, *Publications in Operations Research,* No. 111, New York, 1967.

[24] DE MOIVRE, as under 1, p. 46, — as follows:
"A Table of the Limits.
The Value of "x" will always be:
For a single Event, between 1 q and 0,693 q
For a double Event, between 3 q and 1,678 q
For a triple Event, between 5 q and 2.675 q
For a quadruple Event, between 7 q and 3.672 q
For a quintuple Event, between 9 q and 4.670 q
For a sextuple Event, between 11 q and 5.668 q
Etc.
And if the number of Events contended for, as well as the number q be pretty large in respect to Unity; the number of Trials requisite for those Events to happen n times will be $\frac{2n-1}{2}$ q, or barely nq."

From our line of thought it is of interest that DE MOIVRE inserted already in the first Latin version of his "Doctrine of Chances" the formulas of those generating functions, which later were denominated by LAPLACE as "fonctions génératrices", — but at this time without demonstration.[25] These functions played a great role later in combinatorics and probability theory. The development and the demonstration of them was missing even from the first English version of 1718, and was first furnished in the "Miscellanea Analytica" from 1730.

Another interest from the historical statistical point of view may be found in the appendix made to the 1730-essay, — as already mentioned. In this appendix denominated later by its title as "Aproximatio", DE MOIVRE delineated the values of the factorials "n" as developed in combinatorics and applied a formula, which is equal in principle to the discovery of STIRLING's-theorem.[26] This fundamental formula enabled him to develop the formula of approximation concerning the middle term of the binomial distribution, — hence the terminology of his famous appendix.[27]

The importance of DE MOIVRE's discovery of the STIRLING's-theorem was obscured by the fact that he used a different notation than later STIRLING, and also different mathematical expressions in the solution of the problem, — especially he has not determined the expression "$2\pi n$" and concentrated his efforts to state mainly the parameter "B". His approximation of its numerical value was only with some decimals greater, than the exact value as calculated later by STIRLING.

As regards to the priority in the discovery of this theorem the "Approximatio" may be considered as a main proof of DE MOIVRE's pioneering-spirit. In the "Approximatio" DE MOIVRE mentions that STIRLING attired his attention to the fact that the parameter "B,, approximated by him, must be equal to the square-root of the expression "2". These antecedents are more than enough — according to the discoverer and the first commentator of the "Approximatio", i.e. PEARSON, to attribute the theorem in question to de MOIVRE and not to STIRLING, — even if the latter's name became familiar in mathematical history.[28] From the more recent representants of the history of mathematical science it was ARCHIBALD, who shared and continued in 1949 the tradition of PEARSON.[29]

In our interpretation the discovery of the STIRLING's-theorem by DE MOIVRE was an important step towards the successive discovery of the so-called BERNOULLI-theorem. As widely known, this law of probability was published only in 1713 in the posthumous work of JAMES BERNOULLI, demonstrating that the probability of the result of experiments may be located between definite limits under the supposition that the number of experiments is numerous enough. BERNOULLI concluded from this theorem that by pursueing the experiments indefinitely, we would be able to calculate probabili-

[25] EISENHART—BIRNBAUM, as under 9, p. 26, — with reference to LAPLACE, P. S.: Mémoire sur les suites, Histoire d'Académie Royale des Sciences de Paris, Année 1779, Paris, 1782, — and especially —: Mémoires, Oeuvres Complètes de Laplace, Reprint, Paris 1894, p. 1 and furth.

[26] WALKER, as under 7, p. 16.

[27] WESTERGAARD, as under 18, p. 104.

[28] WALKER, as under 7, p. 16, note 37, — with reference to the fact, that STIRLING has first published this theorem in 1730.

[29] PEARSON, as under 13, p. 403, — and ARCHIBALD, as under 3, p. 45.

ties for all kind of of events, — economic or moral. It is also known that BERNOULLI has neither given any mathematical demonstration of this hypothesis, nor has elaborated its application in the field of social sciences. Thus, the solution of this problem was waiting for the mathematical genius of DE MOIVRE.

V.

DE MOIVRE has not dealt with the solution of the BERNOULLI-theorem in the English-version of his main work. This was first undertaken by him in the first Latin-version in 1733 of his "Approximatio", — which was, according to his own wording, formulated "a dozen years earlier", i.e. at the beginning of the 1720-ies.

It is interesting to note, that this first version, which was inserted, translated in English, in the second English edition of 1738, has not yet given any hints to applications. It exposed only explicitly according to its title the problem of approximation concerning the development of the binomial terms of "$(a+b)^n$", from which "... are deduced some practical rules to estimate the degree of assent, which is to be given to experiments."[30] This part of the title aiming at practical applications of mathematical experiments was not included into the original Latin text.

In our up-to-date terminology the "Approximatio" is identical with the discovery of probability distribution of the binomial terms, or more exactly, with its "normal approximation", — also referred to as the distribution according to the "normal error", or laconically "normal distribution".

To the determination of this probability distribution DE MOIVRE used the numbers "$(1+1)^n$" and to its approximation the ratio of the middle-term and that of the sum of the developed terms, and also the ratio of some other characteristic values for the ordinates of the normal-curve, calculated by the method of mechanical power-raising. To determine these latter selected characteristic values, — among which the "probable error" gained a special significance —, he arrived to elaborate the STIRLING's-theorem in the form as already depicted.

The idea to consider probability as the function of the deviations from some central value, as some "error", has lead DE MOIVRE to the delineation of the maximal value of the ordinate of the "curve of error" with the help of the STIRLING's-theorem and with the values of a circle of unit-radius as given by STIRLING and — at least — to the formula of the curve of error.

According to his numerical example, if the number of experiments is 3600 and the probability of the events is equal to 1/2, i.e. "$p=q=1/2$", then the probability of the function of deviations must be equal to the probable error, or in modern terminology to the "standard error" or "σ". DE MOIVRE has not applied any new terminology for this characteristic value, but he gave it numerically with a very good approximation in 0.682688. In the second English-version of his main work he referred to the square-root "n" as the "modulus regulating the estimation". The halving of the errors was calculated by him in 0.707 standard error, and the value of the probability of the error less than

[30] DE MOIVRE, as under 14, in 1, p. 243.

3 standard errors given in 0.99874, — i.e. all with some minor deviations from up-to-date values.

Our above exposition seems to be enough to show that in the mathematical repertory of DE MOIVRE a complete apparatus of the so-called normal approximation concerning one of the most important mathematical statistical distributions, that of the binomial distribution, was already elaborated and presented. In order to apply this relationship for statistical calculations, a further step was required, namely that this mathematical interdependence should be formulated as a rule of general validity.

DE MOIVRE was looking for the solution of this problem mathematically by the way of extension of the validity of this formula for cases, first, when probability was different from 1/2, and second, by amplifying their limits of estimation, multiplying them by 2 and 3. The results of his calculations in this field — as demonstrated above — are roughly in conformity with those up-to-date values derived from tables of values for the exponential function.

As a further decisive step to prove the validity of a discernible law of probability, DE MOIVRE formulated the following conclusion: "... altho' chance produces irregularities, still the odds will be infinitely great, that in process of time, those irregularities will bear no proportion to the recurrency of that order, which naturally results from ORIGINAL DESIGN".[31] In modern wording one may say that the uncertainty ratio observed in a sample of the magnitude of "n", as an estimated value for a factual uncertainty ratio of a base-mass, is inversely proportional to the square-root of the nth order of the sample itself.[32] This relationship called BERNOULLI-theorem, or in general the "law of great numbers", should be denominated more correctly — according to the above exposition of its scientific curriculum — as DE MOIVRE-theorem.

As regards practical applications — as already referred to — the inversion of the BERNOULLI-theorem was of utmost importance for the further development of statistical methodology.

The exploits of DE MOIVRE are also in this field far-reaching on the basis of the following line of thought, developed in his "Remark II", first inserted into the 1738-edition of his "Doctrine of Chances". There he asserts us: "As, upon the supposition of a certain determinate law, according to which any event is to happen, we demonstrate that the ratio of happenings will continually approach to that law, as the experiments or observations are multiplied: so, *conversely,* if from numberless observations we find the ratio of the events to converge to a determinate quantity, as to the ratio of p to q; than we conclude that this ratio expresses the determinate law according to which the event is to happen...

Again, as it is thus demonstrable that there are in the constitution of things, certain laws according to which events happen, it is no less evident from observation that those laws serve to wise, useful and beneficent purposes to preserve the steadfast order of the Universe, to propagate the several species of Beings and furnish to the sentient Kind such degrees of happiness as are suited to their state.

But such laws, as well as the original design and purpose of their establishment, must all be *from without;* the *inertia* of matter, and the nature of

[31] DE MOIVRE, as under 1, p. 251.
[32] EISENHART—BIRNBAUM, as under 9, p. 26.

all created Beings rendering it impossible that any thing should modify its own essence, or give to itself, or to anything else, an original determination or propensity. And hence, if we blind not ourselves with metaphysical dust, we shall be led, by a short and obvious way, to the acknowledgement of the great MAKER and GOVERNOUR of all; *himself all-wise, all-powerful and good.*"[33]

As the example to prove his thesis, DE MOIVRE has chosen the ratio of male to female births taken from the political arithmetical literature. His deep insight in the problem is demonstrated by the fact that he does not share the point of NICHOLAS BERNOULLI, but that of ARBUTHNOT. According to the latter, the law showing a great constancy is to be found in the different ratio of male and female births and not in their equality. Equality in observations would not possible to obtain even if the time of observation would be long enough and the mass of observations a satisfactorily great number, — contrarily to the speculations of NICHOLAS BERNOULLI. As DE MOIVRE has pointed out, the series of observations of ARBUTHNOT was long enough, extending over 90 years and sufficiently great in number, too.

DE MOIVRE's formulations of such a "Divine Order" reminds the statistician strongly to that of SÜSSMILCH's, the difference being mainly in its earlier date, — from 1738 instead of 1741 —, as DE MOIVRE inserted it first in the second English-version of the "Doctrine of Chances". These ideas are attributed by some scholars to the influence of the deterministic theology as represented by NEWTON,[34] but it may equally ascribed to that branch of enlightened "natural theology", i.e. physico-theology, using statistical methods to prove the existence of God. The latter current of thought was deeply rooted in SÜSSMILCH's thinking and he paid amply tribute to its English representants.

VI.

The order manifesting itself in the ratio of male to female births and its verification by statistical induction may serve us to demonstrate the calculations of DE MOIVRE in the field of annuities on lives. His activities under this heading may also serve to illustrate his ideas in the questions of applied mathematics connected with real statistical problems.

The investigations in these problems acquire special importance when realising that up to our days DE MOIVRE has been considered as a scholar, who has undertaken exclusively the development of mathematical theory dealing with pure methodological problems and contributing only on this way to the elaboration of probability theory and that of mathematical statistics. His ideas concerning the question of the ratio of male and female births are pointing already in the opposite direction, — even if he developed his thought on this problem only in the second English-version of the "Doctrine of Chances", i.e. not earlier than 1738. As already pointed out in the present paper,

[33] DE MOIVRE, as under 1, p. 251.

[34] WALKER, as under 7, p. 18, — and see also SÜSSMILCH, J. P.: Die göttliche Ordnung in den Veränderungen des menschlichen Geschlechts, aus der Geburt, dem Tode und der Fortpflantzung desselben erwiesen..., Berlin, 1741.

[35] DE MOIVRE, as under 1, Preface of the "A Treatise of Annuities on Lives", p. 262.

DE MOIVRE has always bound together the methodological investigation of the law of great numbers in mathematics with experiments in real events, supposed, they were numerous enough to the exploration of the problem.

So he forcibly arrived to the study of the mathematical question of annuities on lives "after two or three years" of the publication of the first English-version of his main work, i.e. around the year 1720.[35] The impulse was given to it by the life-table of HALLEY based on the Breslau-data and on the latter's joint calculations on annuities published at the Royal Society in 1693.[36]

HALLEY attributed in this essay the greatest practical importance in the field of economics to the problem of annuities and the further elaboration of some unsettled questions of the latter helped DE MOIVRE considerably to develop his ideas on probability theory.

In his treatise on "Annuities on Lives" published in 1724 DE MOIVRE worked out the problem how the probability of duration of human life may be approximated by mathematical series in the form of arithmetical or geometrical expansions and how these expansions are fitting to the practical or statistical probability derived from the Halley-table.

The deliberateness of these studies is clearly shown by the foreword of this treatise,[37] — the calculation of the probability of surviving of 1, 2, 3 or more persons and the determination of annuities for different periods for them being closely connected with the knowledge of the limit of the duration of human life, serving from the practical point of view to a limit of these calculations themselves. DE MOIVRE has set this limit — referring to the results of the Halley-table in one year.

He was led by these speculations to settle the sets of the different annuities and to the calculation of their alternate values according to different interest rates (3—6%), — but also to elaborate a general formula covering the probability of surviving of a whole population according to the IXth Chapter of the same treatise.[38] He arrived through these deliberations to reflexions over the more important life-tables of his epoch from the point of view of deviations from his hypothesis, — inventing thus a kind of early "hypothesis testing".[39]

From the far-reaching purposiveness of DE MOIVRE's ideas in this field we may conclude that the close relationship between the calculation of annuities and that of probability theory have been a commonplace for him and so it may not be excluded, that his experiences on the domain of annuities had played a certain role in the elaboration of his "Approximatio", too. A similar effect may be attributed to his experiences on annuities in the ever sharpening formulation of the inversion of the Bernoulli-theorem as regards the successive editions of the "Doctrine of Chances" and the study of events of reality and their laws on the basis of hazard.

The fact that by the end of his life DE MOIVRE insisted on incorporating his deliberations on annuities in his main work is pointing also in the direction that he realised with ever growing comprehension the bridge built by

[36] Ibidem, p. 261, — with reference to the work of HALLEY, however, without title.

[37] Ibid., p. 263.

[38] Ibid., pp. 325 and furth., especially p. 327.

[39] Ibid., pp. 347 and furth.

science between theoretical or mathematical and those of practical or statistical probabilities.

In the posthumous third English edition of 1756 of his "Doctrine of Chances" his friends have fulfilled his scientific last-will and incorporated in it also his "Treatise on Annuities". Among the many Appendices attached to this full-edition of his life-work in the seventh DE MOIVRE has reproduced the life-tables of HALLEY, KERSSEBOOM, DEPARCIEUX, SMART and SIMPSON under the heading "The Probabilities of Human Life, According to Different Authors".[40]

In his commentaries given to them, he outlined, even if only qualitatively, the most important differences existing between his hypothetic method and the contemporary tables as mentioned in the table of DUPRÉ DE ST. MAUR inserted into BUFFON's great work on natural history of wide fame.

DE MOIVRE's deductions in the same appendix are of great interest for statistical methodology, too. Starting from the fact that the different life-tables are based on very different populations as to their number, origin and settlement, — urban or rural, or even living under very special circumstances in religious orders —, he started the exigency of basing the calculation of annuities and that of the life insurance on very numerous populations, if possible on the inhabitants of a whole country. To secure such globality in data it is indispensable — according to DE MOIVRE — to fill the parish-registers in such a regular way as already proposed by "several writers".

Mention is made by name only of the study of CORBYN MORRIS dated from 1751, but this reference may be equally include the similar ideas of SÜSSMILCH on this subject from 1741, already adopted and realized by FREDERIC THE GREAT in Prussia.

Very characteristically DE MOIVRE did not stop at the proposition of introducing all-embracing population lists for the whole country as his predecessors, but by continuing this line of thought he arrived to the final deduction of the idea of a "general census". By the repetition of such general censuses in regular intervals one would be able to survey changes in the most important characteristics of population structure and to furnish "to our governors and to ourselves much instruction of which we are now in a great measure destitute". Under these characteristics he mentioned the married population as against unmarried, those of employed and unemployed, — the latters falling under the Poor's Law —, the population according to profession, especially in industry, the rural and urban population "in each county, city and borough separately, that patricular useful conclusions may be readily deduced, as well as the general state of the nation discovered."[41]

I think, even such a short synthesis as represented by the present paper is able to give a comprehensive picture on the interrelation of abstract mathematical thinking and that of mathematical calculations of practical interest in the field of statistics and that of actuarial science, — denominated from the middle of the XIXth century on as "Political Arithmetics" in the new sense as already present in DE MOIVRE's thought. He went even further than that as the horizons towards he was pointing are englobing not only the whole subject of population and social statistics, but also the statistical cognition of the universe itself.

[40] Ibid., Appendix No. VII, p. 345.
[41] Ibid., p. 348.

That was the reason that he underlined in an addition to his posthumous edition in context with the "Approximatio" the statement of JAMES BERNOULLI as made in his "Ars Conjectandi". According to this passage the law of great numbers has utmost importance as regards practical applications of probability and this law allows us to base our knowledge of the hazard on true science. DE MOIVRE in an additional remark stressed even more accurately that the conformity between theoretical and statistical probabilities was demonstrated "ad oculos" since, despite the fact, that "... Yet there are writers of a class indeed very different from that of James Bernoulli, who insinuate as if the doctrine of probabilities could have no place in any serious inquiry and that studies of this kind trivial and easy as they be, rather disqualify a man for reasoning on every other subject. Let the reader choose!"[42]

VII.

Our synthesis and the special points of view and interdependences existing between the main trends of the scientific activity of DE MOIVRE — we hope — could demonstrate our initial thesis, that the scientific activity of him has a paramount importance not only for early XVIIIth century statistical thought, but also for the contemporary one.

The up-to-date evaluation of his life-work in scientific history is almost independent of the fact that his own epoch was not able to penetrate in his thought and exploit it for every-day statistical purposes. Mostly it is to this lagging-behind on the methodological field and not to the lack of numerous and reliable data — the importance of which having been also clearly realised by DE MOIVRE[43] — that the slow progress of scientific statistics may be attributed in the period after DE MOIVRE. Only the appearance of the great French school of probability — the activity of LAPLACE, FOURIER and POISSON, not disregarding that of GAUSS, too — has laid decisively the foundations of statistics on the probability theory and led to the formation of an established statistical discipline in the system of social sciences, as represented by the activity and results of QUETELET in the first half of the XIXth century. Thus the immediate importance of DE MOIVRE's exploits was obscured for a while as regards both of scientific history and statistical development.

The real value of his exploits was once again rediscovered as a result of the rise of mathematical-statistical thinking, especially in our century. This process was already started by a reformulation of the Bernoulli-de Moivre-theorem, insisting not only on the relative stability of the ratio in sub-populations, but that of the average in samples, the most comprehensively formulated by TCHEBITCHEFF in 1867.

As a further elaboration of this problem, a widening of the Poisson-distribution may be considered, — a problem stated very early again by DE MOIVRE. The occuring of events of little probability with great regularity during a certain period followed logically from this thesis and was incorporated into statistical thought in 1898 by BORTKIEWITZ as the "law of small num-

[42] Ibid., p. 254.
[43] Ibid. Appendix No. VII, p. 348.

bers". In the discovery of this law the investigation into the duration of the phenomenon in question and its occuring, i.e. the consideration of the time-factor, has had a marked importance, representing another question to which the pioneering spirit of DE MOIVRE has contributed essentially. On these bases the modern sampling-theory has been erected and gained a paramount importance for our present days.

Considering the performance of DE MOIVRE in this perspective, it seems to be no overstatement in the verbiage of scientific literature, when it is referred to him as a "mathematical genius" and even the argumentation on our line of thought might be not venturesome to broaden the use of the epitheton "genial" to embrace the field of his activity in applied mathematics too, especially in that of mathematical statistics.

5.

STATISTICAL IDEAS OF ADAM SMITH WITH SPECIAL REGARD TO QUETELET

I.

It is a curious fact that interest — strictly speaking — in the statistical ideas of ADAM SMITH was awaken only on the eve of the bicentenary of his magistral works, — "The Theory of Moral Sentiments" (1759) and "Wealth of Nations" (1776) —, i.e. not earlier than some 15 years ago. I have the short but very stimulating essay of E. RUBIN in mind, published in the "American Statistician" in 1959.[1]

This relatively short article under the technically sounding title "Statistics and Adam Smith" started very modestly by demonstrating, that "... the use, treatment and interpretation of statistics that are available in nonstatistical sources" might be especially interesting on the base of the "Welth of Nations", — a work containing "generalizations of micro- and macro-economics based on very slender statistical foundations".[2] So he included besides "the statistics cited by Smith", a few references about "the statistical concepts he had employed". His concluding remark, that "the purpose of this brief discussion has been to draw attention to Adam Smith *as a statistician*" (my italics!) however goes beyond the well documented part of his essay, namely the verification of his suggestion, that ADAM SMITH's work "is a valuable repository of historical quantitative data".[3]

May we speak of ADAM SMITH "as a statistician"? — the challenge of RUBIN is worth-while of reconsidering one year before the bicentenary of his main work, just before the 40th Session of the International Statistical Institute, the international scientific academy of statistical discipline. By taking up the initiative of RUBIN at this occasion, the discussion of the present contribution or some further publications on the forthcoming 41st Session in 1977[4] may throw fresh light on the question how statisticians see it and how their efforts could implement the contributions of scholars of the history of economic thought.

[1] RUBIN, E.: Statistics and Adam Smith, *The American Statistician*, 1959, Vol. 13, No. 2, pp. 23—24.

[2] Ibid., p. 23.

[3] Ibid., p. 24.

[4] My similar initiative at the occasion of the centenary of QUETELET's death on the 39th Session found a wide echo in Belgium during the "Année Quetelet" in 1974, — compare with HORVÁTH, A. R.: The Centenary of Quetelet's Death and the Development of Statistical Discipline, *Proceedings of the 39th Session, Bulletin of the International Statistical Institute*, Vienna, 1973, Vol. XLV. Book 1, pp. 548—554.

II.

There is a wide gap between such opinions on ADAM SMITH and statistics as that of SCHUMPETER, — according to which the inspiring message of the political arithmeticians „. . . wilted in the wooden hands of the Scottish professor and was practically lost to most economists for 250 years . . ." — and that of RUBIN speaking of him finally and simply as a statistician. The concluding remark of the quotation from SCHUMPETER ends up by saying, that "Adam Smith took the safe side that was so congenial to him when he declared (Book IV, Ch. 5) that he placed not much faith in Political Arithmetics".

The author of the present paper thinks, that both opinions quoted are surely overstatements and the truth must lie somewhere between the two extremities: neither ADAM SMITH himself, nor his epoch considered him "a statistician" and "a fortiori" not, as at his time neither the autonomous statistical discipline nor the state practice of statistical offices was formed, this development was realized only in the next century under the impact of QUETELET. — Even if the scientific erudition of ADAM SMITH incorporated many elements of statistical thinking from the tradition of earlier scholars, which may have passed unnoticed because of the above-mentioned time lag between the formation of classical political economy and the statistics as an autonomous discipline, — it seems to be a promising field of research. Thus for a scientific historical argumentation a closer analysis of the two opinions under consideration may bring some further evidence for our line of thought.

Let us begin with the quotation from SCHUMPETER, — i.e. with the problem of ADAM SMITH's statistical sources and his erudition concerning statistical thinking. Generally speaking has he really placed "not much faith in Political Arithmetics" or yes? Book IV, Chapter 5 of the "Wealth of Nations" treats the "Bounties" on exportation of corn with a subsequent "Digression" concerning the corn trade and the corn laws. The latter tries to fix the proportion of corn import to that of corn consumed per year and the proportion of corn exported to that of corn produced annually with reference to the *"author of the tracts upon the corn trade"*. The estimates from this author calculated in ratios are as follows:[6]

Ratios, resp. %-shares:	Home market Home market	Import	Export	%	%
Grain consumed	570	1		= 0.18	
Grain produced	30		1		= 3.3.

It is only in this very special context, that ADAM SMITH declares: "I have no great faith in political arithmetic, and I mean not to warrant the exactness of either of these computations. I mention them only in order to show of how

[5] SCHUMPETER, J. A.: *History of Economic Analysis,* Edited from Manuscript by BOODY-SCHUMPETER, E., Third Printing, New York, 1959, p. 211.

[6] SMITH, A.: *An Inquiry into the Nature and Causes of the Wealth of Nations,* The World Library of Standard Books, A careful Reprint of Edition 1812, London, without date, p. 418.

much less consequence, in the opinion of the most judicious and experienced persons, the foreign trade of corn is than the home trade."[7]

In consequence, this passage is — according to my interpretation — not a general value-judgement on political arithmetics on the whole, but an opinion in a very concrete matter: concerning the estimations of a third person on the ratios of the volume of grain import and export to the volume of annual grain consumption and production, respectively. This interpretation is in conformity with the history of political arithmetics, the application of which developed in a different way in the field of demographic and economic statistical data.[8]

The position of the applications in demography in the 1750—60-ies was a far better one owing to two circumstances as regards scientific foundation and statistical methodology. On the one hand, the collecting of demographic statistical data of larger collectivities, — towns, regions, even provinces — was not an insoluble one, even with the methods of solitary scholars. Modest progress was also made in holding censuses of the whole population as a main task of state-administration in the bigger countries under cameralist influence and in some American colonies. On the other hand, progress in this field facilitated the synthesis of demographic data from all countries and made it possible to work out international comparisons for larger or smaller communities. The application of statistical induction, i.e. the use of the law of great numbers lead to discover "natural laws" of supposedly static populations. Methodically these observations of populations of different size and with different margins of error greatly facilitated the implementation of the methodology of estimates on a probability basis with tolerable and calculable limits of errors and this scientific development contributed to the formation of demography as an autonomous discipline.

The situation concerning applications in the field of economic statistics was a considerably unfavourable one. Statistical numerical observations of the macroeconomic unit represented by the national state were scanty and even partial economic aggregates, as the balance of trade, were difficult to collect by political arithmeticians. Therefore only conventional and very crude methods of estimations were current instead of statistical induction, — with perhaps the only exception of price statistics, where macro-economic data were collected by the use of averages and national samples mainly for the most important staple article of the age, i.e. grains. In vain was the establishment of stately managed political arithmetical fact-finding bureaus for the estimate of national exonomic aggregates proposed by the Physiocrats: this idea was only partially realized in the form of a French Bureau of the Balance of Trade in ADAM SMITH's time.[9] However its results were poor and kept secret for

[7] Ibid.

[8] Compare with HORVÁTH, R. A.: Some Basic Problems and Historical Development of Political Arithmetics Reconsidered, *37th Session of the International Statistical Institute*, London, 1969, *Contributed Papers*, pp. 35—37 (Summary).

[9] HORVÁTH, R. A.: Quesnay, the "Tableau Economique" and the Statistical Discipline of Our Days, *Statisztikai Szemle*, 1971, No. 12, pp. 1286—1309, — with reference to DUPONT DE NEMOURS on p. 1303 (Hungarian text with English and Russian summaries), — and from the SAME AUTHOR: The Development of Statistics in France and its lessons for Hungary, *Acta Universitatis Szegediensis, Sectio Politica et Juridica*, Tom. XIV., Fasc. 4, Szeged, 1967. pp. 1—126, — with reference to the "Bureau de la Balance du Commerce" on p. 45.

the public, and the progress in countries under cameralist influence was in Central Europe not much better.

So we have to agree fully with ADAM SMITH on the reliability of the corn trade estimate of the unknown author quoted by him not only about the fraction of the import-export share, but also as regards the base, i.e. national grain consumption and production in general. It seems to be superfluous to refer to up-to-date official economic statistics, where margins of error still present a problem, e.g. in modern British national accounts statistics of gross national product, where they stood around 3% for imports and exports of goods and services and up to 10% for the base aggregate in 1966.[10] Every modern economist, planner or economic statistician would agree with ADAM SMITH, that not the numerical ratios but only the underlying tendencies of the phenomena give a sound basis to conclusions from such kind of political arithmetical estimates as referred to in this context. So the spirit of contemporary statistics was basically understood by ADAM SMITH which is also clearly shown by his preoccupation of the reliability of statistical observations and estimates, as well as by his excellent use of demographic data and corn price statistics, as rightly quoted by RUBIN.[11]

In many ways ADAM SMITH, blamed for not being generous with the identification of his sources or acknowledging their merits,[12] performed better than his critics suggested, — perhaps much more so concerning statistical than theoretical economic sources. As well as the political arithmetical authors quoted by SCHUMPETER[13] we encounter as the most important ommission of his among the countrymen of ADAM SMITH the name of GREGORY KING "a man famous for his knowledge in matter of this kind" (estimated average prices of wheat) and among French political arithmeticians and consultant administrators those of ABBÉ TERRAY, DUPRÉ DE ST. MAUR, MESSANCE, BUFFON, DUTOT and DUVERNEY, — a very impressioning set of names in itself,[14] — not to speak of the Physiocrats themselves. The roots of the Smithian interest in Political Arithmetics may go even deeper than this, owing to the polyhistoric character of his knowledge: he had a lot in common with SÜSSMILCH in his studies in natural theology and natural law, not only in the parallelism between "Divine Order" and "invisible hand" and the research in the origin of language,[15] — and he is certainly foreshadowing QUETELET not only with his astronomic and social interest, but also in stressing the importance of reliability when using statistical data.[16] The connection between the basic concepts of ADAM SMITH and QUETELET does not end here. In the next part of my study I want to enlarge the hint of SCHUMPETER that "his

[10] Central Statistical Office: *National Accounts Statistics, Sources and Methods,* Edited by MAURICE, R., London HMSO, 1968, p. 470.

[11] RUBIN, op. cit., pp. 23—24.

[12] SCHUMPETER, op. cit., p. 182.

[13] Ibid., p. 183, — with reference to PETTY, CHILD, NORTH, DAVENANT and POLLEXFEN.

[14] SMITH, op. cit., — pp. 169, 85, 171, 193 and 255, respectively.

[15] SCHUMPETER, op. cit., p. 182.

[16] HORVÁTH, R. A.: Le Concept de Statistique Internationale et son Evolution Historique, *International Statistical Review,* 1972, No 3, pp. 281 and furth. — esp. p. 286.

system was the channel of 18th century ideas for 19th century economists about human nature" also towards the economic statistical direction of the conceptual apparatus.[17]

III.

I think the remark of SCHUMPETER on the importance of the Smithian teaching on human nature has very farreaching consequences, because these ideas laid down the foundation for the theory of production on the base of the static equilibrium of the economic system and its market mechanism. The connection between economic mass sociology and the economic analytical scheme of equilibrium — the latter being according to SCHUMPETER "the core of the analytic performance" of SMITH in Book V and reformulated by WALRAS "on an ifinitely higher level of rigor"[18] — was perhaps better understood hundred years ago, when HELD was analysing the similarities between the Smithian and the Queteletian thought.[19]

In his study HELD was stressing the fact, that SMITH "not completely unconsciously" identified the economic man of common-sense egoism with the average real man of the society, and for illustration he quoted from the "Wealth of Nations" Book II, Chapter 2 the following sentence: "Though the principles of common prudence do not always govern the conduct of every individual, they always influence that of the majority of every class and order."[20] By this "double abstraction" according to HELD — SMITH substituted the sociological behavior of men to their economic self-interest and took from the so conceived men only the average man as the type of society. By this induction SMITH was able to treat economic behavior as the main determining factor of the present state of society, or in up-to-date terminology, to express it as macro-economic data by inserting them as elements in the equilibrium analysis among such other elements like social product, national dividend, or wages, profit and rent.

This reasoning was "a fortiori" enhancing as — in SCHUMPETER's wording — "Human beings seemed to him much alike by nature, all reacting the same simple ways to very simple stimuli, differences being due mainly to different training by different environments."[21]

The emphasis laid on the "impersonal" character of this macro-economic entity as a factor of economic sociology paved the way to the introduction of the economic mechanism of market forces and the theory of economic equilibrium as a concept of stationary state. One has to agree with SCHUMPETER, that this concept was implicitly given in the Smithian system as a "tool of analysis for the isolation of groups of economic phenomena observable in an unchanging economic process".[22] Its methodological importance according to him was first explicitly recognized only by J. S. MILL and MARX. The next

[17] SCHUMPETER, op. cit., p. 186.
[18] Ibid., pp. 834—35.
[19] HELD, A.: Adam Smith und Quetelet, *Jahrbücher für Nationalökonomie und Statistik,* Band 9, 1967, pp. Band 9, 1967, pp. 249—279.
[20] Ibid., p. 264—265.
[21] SCHUMPETER, op. cit., p. 186.
[22] Ibid., p. 562.

step was the consideration of these macro-economic entities as probabilities and the law of their relations as natural law, — in the form of statistical functions, representing stochastic processes, ensueing from the free interaction of individuals validating their self-interest as statistical units of a randomized statistical set.

In a recent paper — treating the economic concepts of QUETELET — I demonstrated by making use of the criteria of TINBERGEN, that every econometric reasoning started from this step[23] and in this sense the Smithian analysis was also in essence an "econometric" one. HELD, without being able to think in econometric terms hundred years earlier, was very near to understanding this truth. He wrote, that the stepping stone to every analysis is... "even when operating with a, b, and c and not yet with 1, 2 or 3 — to locate the positions ("Stelle"), where one can substitute the calculated values and find out the form of the equation, which determines the relation among the figures."[24] This early formulation has the merit of showing clearly the antecedents of the performance of QUETELET, who argued in social physics to fill up with statistically observed figures the statistically operational macro-economic concepts and so to find out the probabilistic statistical function, which gives their law. These requirements were foreshadowing econometrics in the modern sense.[25] From the methodological point of view in the Smithian system the inductive logic, — with all its consequences derivating from the theory of cognition and familiar to statisticians, — plays a key role.[26]

To be able to discover the general characteristics of the new, profit motivated capitalist economic system, SMITH massed up individual statistical and historical informations. The investigation of the resulting macro-economic concepts was performed by an analysis through abstractions from the composite individual elements to seize the general, — the average man or "homme moyen", — as long as the subject of analysis were men. To the completion of this investigation the social product and the productive process were put in the focus of interest to establish a scientific system of capitalism. On the basis of Cartesian logic a deductive logical structure with the pertaining synthetic method led only to further results: this helped to explain the complexities of products and productive processes in manufactures and in the factory system. These latter elements in the system determined the "impersonalization" of men in the economic process, so as to be in conformity with the system of products as a whole, — even when the results of the inductive logic were not statistically proven, only deduced from facts known as reliable and "usually" or "on

[23] HORVÁTH, R. A.: Economic and Economic Statistical Conceptions of Quetelet, *Statisztikai Szemle*, 1974, No., 8—9, pp. 818—827. (Hungarian text with English and Russain summaries.) — with reference to TINBERGEN, J.: The Significance of Keynes Theories from the Econometric Point of View, *The New Economics*, — Ed. by HARRIS, S. E., London, 1947, pp. 120 and furth. — see a French version of this paper under the title: Sur les Conceptions Economiques et de Statistique Economique de Quetelet, in the volume from the SAME AUTHOR: Quetelet et la Statistique de son Epoque, *Acta Univ. Szegediens., Jur. et Pol.*, Tom. XXIII, Fasc. 3, Szeged, 1976, pp. 33 and furth.

[24] HELD op. cit., p. 257.

[25] QUETELET, A. L.: *Physique Sociale*, 2d Ed., Bruexelles—Paris—St. Petersbourg, 1869, Vol. 1, p. 112.

[26] The author of the present paper served the excellent little study of FORINTOS, Gy.: The Forms of our Reasoning and the Organisatorial Forms of Action, *Valóság*, 1974, No. 10, pp. 1—18. (Hungarian text.)

the average" considered as true in the Smithian sense.[27] The methodology of the whole reasoning in itself thus implied the probabilistic character of the scientific edifice so constructed, — even without using statistical data, but only a, b and c concepts, implying, — however — its being statistically operational.

To work out his ideas on these lines is the greatest and real merit of ADAM SMITH from the point of view of the development of statistical discipline and especially of economic statistics, — and so the exposition of the conceptual apparatus of ADAM SMITH by RUBIN was surely justified, even without further investigation.[28]

IV.

My comments on the statistical ideas of ADAM SMITH — given in parts II and III of my short paper — would not be complete, even by leaving out such specific methodological problems as the use of index numbers in the Smithian system, without one additional remark. It is essential to show how strongly SMITH was aware of the heavy sociological implications of the double abstractions concerning the "economic man". This is clearly demonstrated by his preoccupation to secure the free play of market forces and to avoid every interference from both sides, — i.e. from monopolies on the individual side and from state intervention on the collective one: the interruption of the free flow of labour and capital offsets this "simple system of natural liberty" he was aiming at.[29] Statistically, these forces are offsetting the randomized character of the statistical distribution and let enter into the mechanism institutional forces alien to the system and applicable only on a new methodological basis, i.e. correlation and covariation theory.

As A. SKINNER rightly pointed out, social harmony in the Smithian system is much more sophisticated, than supposed; self-interest operating in the social and especially political field may blunt the effectiveness of economic mechanism and create opposition of interests not only between individuals but also between classes, especially between labourers and employers. Thus SMITH was anticipating the Marxian thesis of alienation,[30] — surpassing by far the philantropic Rousseauism of the epoch.[31] The forces in question may be fortified even by economic factors equally creating antagonism, by the coherent methodological framework of the system — as explained in part III of our study —, and partly also by the division of labour itself and by the size of the market. The same preoccupations were haunting QUETELET at the perfection of statistical operability of the contemporary capitalist economic system, — as analysed "in extenso" in my quoted paper in Hungarian.[32] QUETELET's fear that the working conditions of the Industrial Revolution may destroy the human capital, was a very real one and induced him to argue in his social

[27] HELD, op. cit., p. 259. — with reference to Book 1, Ch. 9: "It is not easy to ascertain what are the average wages of labour even in a particular place and at a particular time. We can seldom determine more than what are the most usual wages."

[28] RUBIN, op. cit., pp. 24—25.

[29] SKINNER, A.: Lesson of Profits Prophet, *The Times*, June 5, 1973, p. 16.

[30] Ibid.

[31] SCHUMPETER, op. cit., p. 186.

[32] HORVÁTH, op. cit. under (22)

treatise in favour of an industrial legislation also in Europe, — with reference to the opinions of contemporary French and German economists, — especially WOLOWSKI,[33] — without contest, in the true spirit of ADAM SMITH's ideas.

[33] QUETELET, A. L.: *Du Système Sociale et des Lois qui le régissent*, Paris, 1848, p. 338. — with reference to WOLOWSKI, M. L.: *Cours de Législation Industrielle*, Paris, 1840, p. 16.

6.

ADAM SMITH' PERFORMANCE IN THE FIELD OF INDEX-NUMBERS

I.

In a previous paper of mine I tried to draw the attention of the scientific public to the fact, that the theoretical activity of *Adam Smith* is showing a deep erudition in statistics and an outstanding ability to use statistical methodology for economic analytical purposes.[1] In my paper — representing a first approximation in this subject on my part — I have given already a hint in the direction, that the use of index-numbers and the theoretical implications of their application is also representing an important side of his scientific activity, furnishing another argument in favour of his statistical abilities.

The latter problem was also mentioned by the American statistician *E. Rubin* in an article published some one and a half decade ago.[2] This article considered the publication of the corn prices in tabular form in *Smith'* main work, as an outstanding example of economic statistical applications covering the period from 1202 to 1764, — even if this collection of prices does not embrace every year for the whole period. *Rubin* stressed also the fact, that *Smith* for the proper use and application of these data for analytic purposes recalculated the current prices on the stable level of his own time and that for their evaluation he leaned primarily on the calculation of the arithmetic mean. The article of *Rubin*, at last, quoted the text of *Smith* revealing his sources, the collection of *Bishop Fleetwood*, and *Smith'* remark how he filled the gap in the original data for the years 1598—1601, together with his statement how he evalued the data based on the 12 years group averages and how he stated his main conclusion, i.e. that the tendency of the corn-prices was falling till the mid-16th century and from this time on how it was rising till to his own days.

However, it must be stressed from my own point of view, that the final comment of *Rubin* concerning the problem of corn-prices and the problematics of the application of index numbers is attributing to them no great statistical significance, but rather an economic historical one. He held, his complementary commentaries are pointing more into the direction of business cycles theory, than into that of index-numbers. He insisted namely, that *Smith* was not only interested in long-swing movements of corn prices, but also in short-term fluctuations as a consequence of bad harvests and the resulting scarcity of main agricultural products.[3]

[1] *Horváth, R.:* Statistical Ideas of Adam Smith with Special Regard to Quetelet, Contributed Papers, 40th Session of the International Statistical Institute, Warszawa, 1975, pp. 392—400.

[2] *Rubin, E.:* Statistics and Adam Smith, The American Statistician, 1959, Vol. 13, Nr. 2, pp. 23—24.

[3] Ibidem.

These commentaries of *Rubin* on the whole rested thus on the level of the general reader of the "Wealth of Nations" and omitted to state the problem explicitly. Namely: the scientific analysis of the Smithian work from the point of view of applied economic statistics — more closely his use of index-numbers and the scrutiny of the underlying statistical methodological and theoretical implications — has to be done, if we want to better understand and revalue the analytical apparatus of *Smith.* As neither *Rubin*'s article, nor my above mentioned paper had taken up this problem, its scientific verification has remained an open question up to the present.

The scope of the present paper is to fill this gap by examining *Smith'* activity in this field on the basis of his main work, the "Wealth of Nations". The present venture is of course only a first approximation in this field, nevertheless, it may start the revaluation of the Smithian way of scientific reasoning on statistical foundations.

II.

Let us begin with the problem of sources as *Smith* himself had done it. It is a well known fact that *William Fleetwood,* Bishop of Ely, has collected the corn price data in 1707 to answer the question posed by a student, wether the money for the maintenance of the students of Oxford University in his time was able to secure the "same Ease and Favour" for them as some 260 years before. The problem so stated was identic with the purchasing power of money or crudely with the real general level of life, — even if the purchasing power of money was only represented by the average prices of the most important subsistence article, i.e. by the prices of corn.[4]

The statement of the problem in such a way was basically sound and is in accordance with the formulation of the basic problem by the modern index-number theory, notably that this theory has to answer the problem how one could compare the different levels of two or more observation units registered in the same time, — or — and this is the point in question — how one could compare the fluctuations in the level of the same observation unit registered during a period of time.[5] With *Fleetwood* the observation unit was the subsistence cost of a student measured representatively by the price of corn.

The first question ensueing from the statement of *Smith'* sources is wether he applied the corn-price data for the investigation of the same problem. It is not without statistical interest to note, that his starting point was an alternative one, he sought not the alternances of the general level of life, but those of the purchasing power of money and has clearly recognized the substitution possibility in this interdependence from the statistical point of view. This was identic with the discovery of the quantity—theory formulated the most pregnantly by the monetary school of modern economic thinking, by *Irving Fisher,* at the beginning of our century by treating the general price-level and the value of money as reciprocal quantities.

According to the Smithian thinking the equation of the interdependence

[4] *William Fleetwood:* Chronicon Preciosum: or, an Account of English Money, the Price of Corn and Other Commodities, for the Last 600 Years, — in a Letter to a Student in the University of Oxford, London, 1707.

[5] *Ulmer, M. J.:* The Economic Theory of Cost of Living Index Numbers, New York, Second printing, 1950, p. 28.

should be valid also under very crude statistical representation of the general price level, as in an overwhelmingly agrarian community it is given by the price of the most important subsistence commodity: corn. This reasoning implies some concept of "statistical approximation" and "statistical dispersion", or even some notion of "error" by not satisfactory representation, too. The Smithian "common sense" functioned thus without failure and secured a sound methodological basis to his investigations concerning the changes in the purchasing power of money, or more exactly the silver currency of his and preceeding periods. A further proof that *Smith'* reasoning in this question was a deliberate one, may be furnished by his economic line of thought, as he was aware, that price fluctuations may be generated not only from the commodity-side, — i.e. by scarcities or plenties in the volume of useful goods —, but also from the money side, that is by the autonomous changes in the value of the currency.[6] Therefore I venture to say, that in this problem his understanding was far from vulgar statistical thinking and was on an equal footing with his "classic" economic ideas.

A closer examination of the tabular data as published by *Smith*[7] reveals, that he completed not only the corn-price statistics of *Fleetwood* for the four years mentioned by him (1598—1601), but he prolonged the series to his own time, to 1764 by yearly figures without any interruption creating thus a second kind of coherent tables. This is a sensible difference as compared to the data collected and published by *Fleetwood*, which were fragmentary for the time before the 16th century. They distribution was also a very uneven one, despite the fact of their grouping into 7 periods both containing 12 yearly price notations. The uneven distribution of the data is characteristic also for the continuous yearly series in the first third of the 17th century, where the subsequent groups are containing 26 (group 8), 16 (group 9) and 64 (group 10) years. Were the data for the years 1642—1645 in the last group from the 17th century not missing in the account, the simmetry or parallelity could have been completely restored between the two last groups (groups 10 and 11) as the last group coverning the 18th century embraces also 64 years but without interruption in the price notations. (See Table I on page 70)

From this last group we may conclude that *Smith'* most important completion of the *Fleetwood*-series is represented by this very last group of data, i.e. from 1701—1764 and that it has served for him to furnish an average for his century on an extended basis. So he was able to compare it with the previous period in the 17th on an approximately equal time-base. This hypothesis seems to be realistic enough even in absence of the *Fleetwood*-publication, which I was not able to consult before the redaction of my paper. However, it seems to be certain, that the forming of a series of 64 years for the 18th century for the sake of comparison with the immediately preceeding period, points to the idea of an identical statistical basis. At the same time the neglection of the perfectly equal footing of comparison through the 4 missing yearly data confirms my previous opinion that *Smith* was aware of the possibility and the restrained importance of statistical errors when calculating statistical averages with not too reliable data, but on an extended basis.

[6] *Smith, A.:* An Inquiry into the Nature and Causes of the Wealth of Nations, London, G. Routledge and Sons, no Date, pp. 141 and furth.

[7] Ibid., see the tables on pp. 203—206.

[8] *Kendall, M. G.:* Time-Series, London, 1973, p. 19 and foot-notes (1)—(3).

Table I

Recapitulation and Completion of the Smithian Tables

1	2	3	4	5
Number of the group	Starting and ending year of period	Number of yearly data contained in period	Time-span of period in years	Average-price of period (£/sh/d)
1	1202—1286	12	84	2 (19) 1 1/2
2	1287—1338	12	51	1 (18) 8
3	1339—1416	12	112	1 (5) 9 1/2
4	1423—1451	12	28	1 (1) 3 1/2
5	1453—1497	12	44	0 (14) 1
6	1499—1560	12	61	0 (10) 0 5/12
7	1561—1601	12	41	2 (7) 5 1/3
8	1595—1620	26	26	2 (1) 6 2/12
9	1621—1626	16	16	2 (10) 0
10	1637—1700	64	64	2 (11) 0 1/3
11	1701—1764	64	64	2 (0) 6 12/32
12	1731—1740	10	10	1 (17) 3 1/2
13	1741—1750	10	10	1 (13) 9 1/2

The last two tables in the Smithian record, i.e. the third kind of tables are recapitulations from the group 11 from 1701—1764, showing ten year periods and their averages for 1731—1740 (group 12) and for 1741—1750 (group 13). The reason to form such conjunctural series — as *Rubin* rightly pointed out — was to detect price fluctuations in which the effect of bad harvests played an essential role instead of fluctuations on the side of money. The existence of these two tables seems to confirm also my guess that *Smith* was perfectly aware of the two-way interaction of factors from the commodity and from the money side in the index-number problem, that is, he understood equally well the problem from the statistical methodological and from the causal economical side.

A further conclusion drawn from the grouping and utilisation of the data for economic analytical purposes may be that — contrary to *Rubin*'s views — — *Smith* concentrated his analysis to his own time and to the 17th century. So his interest was far from an economic historical one. He aimed primarily at the understanding and identification of the forces at work in the rising capitalist-era. This conclusion may be confirmed by a much closer examination of the tabular data in the main Smithian work and especially on the basis of the simple underlying statistical technique, which may be detected from the arrangement of the tables and the textual interpretations closely connected with them.

III.

For a better demonstration of my above deliberations a recapitulation of the Smithian tables may be useful, — retaining only the begining and end of the time-period-groupings and the respective price-averages of the periods, completed with the number of years in each group and the with the time-span covered by the different periods (See Table I).

The above recapitulation may clearly show that there are three different kind of tables reunited in the material of the "Wealth of Nations", which I have separated in Table I by dividing lines.

The first series runs from the beginning of the 13th to the end of the 16th century, containing groups 1—7 based on an equal footing on the prices of 12 years. However the time-spans covered by these periods are very different, the maximum represented by 112 (group 3) and the minimum by 28 years (group 4). The wide dispersion of the data within each period or 12-years group could be demonstrated also by the standard deviations calculated from the averages from *Smith*. However from the point of view of statistical technique and methodology, the basic problem of this first period is the unequal distribution on the different "ranges" of the said 12 data-periods, because — employing statistical terminology — the data of these time series are forming a "discontinuous distribution in time".

The analysis of such kinds of time-series presents even to-day the most serious problems for up-to-date statistical theory —, the difficulty inherent in these problems is clearly shown by the fact, that even modern statistical manuals are treating almost exclusively the analysis and methods of continuous time-series for which a probabilistic theoretical basis was elaborated. Such a theoretical basis for the discontinuous time-series analysis is not yet given and the statistical reader scarcely finds hints for their methodological treatment. The recent monography of *M. G. Kendall* for instance gives only in footnotes his opinion about the backwardness of this part of the time-series analysis. He quotes in this context the theory of *Daniels* from 1970, based on correlation theory and proposing as the most characteristic mean-value of such kind of discontinuous series the mid-range, i.e. the average of the two extreme units, with the highest and lowest value in the series of unequal time-span and unequal distribution. *Kendall* agrees with *Daniels* so far, that he considers also the analysis of such series as belonging to the field of stochastic processes, but he considers, the methods brought up so far are concentrating on the queuing-problem and had till now no applicability to the time-series analysis.

By calculating for the 13 or more precisely for the 11 basic groups or periods, the tendency shown by the Smithian analysis on the basis of mid-ranges is not altered sensibly and is furnishing another proof of the statistical vein of the father of modern economics. The only difference is that the level of the initial period (groups 1—8) is much higher and the fluctuations in the modern period (groups 9—11) are more smoothered. But the tendency remains as before: a marked and continuous fall in the corn prices till the mid-16th century and a sharp rise from this time on with some minor fluctuations till *Smith'* days, with a slight tendency to stabilize on this more elevated level in the 17th and 18th centuries as shown in Table II:

The above statistical tabular analysis is bringing no different conclusion as formulated in the "Wealth of Nations" for the first period. It is giving only a somewhat higher general level for the seven 12 years-based periods and confirms the modern tenets of index-number theory, that even in lack of accuracy of the basic data, the tendency may be quite accurately shown by appropriate statistical indicators.

Table II

Averages and Mid-Ranges for 13 periods and their Deviations

1	2	3	4	5
Number of period	Time-span of period	Smith' averages	Calculated mid-ranges	Deviations to *Smith*
			(£/sh/d)	
1	84	2 (19) 1 1/2	8 (11) 0	+ 5 (11) 10 1/2
2	51	1 (18) 8	3 (2) 3	+ 1 (3) 7
3	112	1 (5) 9 1/2	1 (13) 5	+ 0 (7) 7 1/2
4	28	1 (1) 3 1/2	1 (10) 8	+ 0 (9) 4 1/2
5	44	0 (14) 1	0 (18) 8	+ 0 (4) 7
6	61	0 (10) 0	0 (18) 0	+ 0 (8) 0
7	41	2 (7) 5 1/3	2 (10) 0	+ 0 (2) 6 1/2
8	26	2 (1) 6 2/12	2 (9) 5	+ 0 (7) 10 10/12
9	16	2 (10) 0	2 (8) 0	— 0 (2) 0
10	64	2 (11) 0 1/3	2 (15) 1	+ 0 (4) 0 2/3
11	64	2 (0) 6 12/32	2 (11) 8	+ 0 (11) 1 20/32
12	10	1 (17) 3 1/2	1 (13) 8	— 0 (3) 6 1/2
13	10	1 (13) 9 1/2	1 (15) 9	+ 0 (1) 11 1/2

The somewhat cruder method applied by *Smith*, i.e. the use of group averages instead of moving averages to locate the trend, is a more static method than applied in up-to-date methodology. The former compares different levels for different periods, but functionally it is also a dynamic comparison, only less powerful. The lack of accuracy is even fortified by the application of simple arithmetic averages for the discontinuous time-series as in this case the probabilistic foundations of averages are missing, too, — and one ought to speak instead of "real statistical averages" only of "formal", or "notional" averages, as *M. J. Ulmer* has done it, when referring to the data of *Fleetwood*.[9]

From the commentaries of *Smith* concerning this first period there is no doubt how clearly he realized the ambiguous character of these data, the lack of homogeneity in the time-span and in the distribution of the periods covered, the great margin of possible error in the individual data and also in the whole series. Therefore he concluded that only the great tendency has relevance and there is no need to enter into detailed economic analysis of this first period. What he has done instead is a critical evaluation of these early corn-price notations from the point of view of economic history and so he was able to arrive at relevant corrections also in the second period, based on yearly figures of the 17th and 18th century.

[9] *Ulmer*, op. cit., p. 28.

IV.

The critical evaluation of the sources of data by *Smith* started from the economic historic background of the role of corn-price in the English and Scottish economic life as a standard to regulate agricultural wages from the 13th century on. Feudal landlords, especially ecclesiastical ones, started to fix in this form the wages of their employees and in the next century, in the 14th, there were royal commissions formed to settle this question in a general way. The practice rested on the principle of establishing a maximal price-level to not to let augment wage-claims without limit, this purpose was arrived by the notation of the highest prices on a few but most important markets in a representative manner.

Of course these highest prices of corn were an upper limit as a standard for generally accepted wages and the medieval practice deduced from it the "usual", "normal", "common" or "average" wages, which were differenciated enough according to local circumstances. So the idea to use the notion of "average" for economic purposes became a very common one in Anglo-Saxon thinking in the late medieval period, when the monetary economy gradually has taken the place of natural-economic conditions. This process seems to start and generalize much earlier in Britain than in the continental development as the table of *Bishop Fleetwood* for the years 1202—1286 is showing. Here from the three different price-notations for the year 1205 (—0/12/0, —0/13/4, —0/15/0—) the average price is given (—0/13/5—). This practice was maintained till the time of publication of *Fleetwood*'s tables, to 1707.

Another proof of the preference for averages in Anglo-Saxon versus continental development is the Smithian application of them for economic analitical purposes marked by the year of publication of the "Wealth of Nations" itself. This statistically minded approximation of economic problems through averages appears in the continental economic literature almost a century later. As I have shown in another paper of mine, *Quetelet* wentured into such kind of speculations in a work dated from 1848 and *Marx* in the first volume of his main work in 1867 only. It is also characteristic from the point of view of the history of economic and economic statistical analysis, that both scientific giants of the 19th century were referring to 18th century-sources, when mentioning the first appearance of averages for economic purposes.[10]

It would be however erroneous to conclude from the above line of thought, that the Smithian performance was a simple reference and adaptation of already avalaible statistical methods. His comprehension of the whole problem is demonstrated in his step to transform the price-data of the Fleetwoodian-document into real averages in the statistical and economic sense. The first, i.e. statistical methodological part of this cognition-process we were already hinting at, when we referred to the abandonement of the idea of the early "notional" or "formal" averages with different time-span and unequal distribution for the sake of an average based on yearly balanced data on an extended time basis. The economic side of the problem consisted in the reduction of the price quotations from their maximal level to the medium-level, i.e. to

[10] *Horváth, R.:* Economic and Economic Statistical Conceptions of Quetelet, Statisztikai Szemle, 1974, Nr. 8—9, pp. 818—827. (Hungarian text with English and Russian summaries)

the real economic average. This average ought to be under the level of the usual maximal quotations and in default of such registration there was no other source for them as the common knowledge of economic conditions, corresponding to *Smith*' own experiences in this field. Both points of view, the statistical methodological and the practical economical ones, forced *Smith* to give up the possibility of such corrections for the time before the 17th century, — which is another proof of his interest for the economics of his own time and his lesser preoccupation for economic history.

Smith established that the "average corn-price" has lain in the 17th and 18th centuries by 1 bushel below of the maximal price of the quarter of wheat by 9 bushels. According to him the yearly notations provided by the Eton-College registers and representing the medium of the "best or highest priced Wheat at Windsor-market on Lady's Day and Michaelmas" was to reduce in money-value by 1/9 to arrive to a real economic average. The result of these corrections may be summarized from the "Wealth of Nations" as follows in Table III:[11]

Table III

Corrections of Smith to create Real Economic Averages

1	2	3	4
Number of period	Time-span of period	Old Maximal Price-Averages	Reduced New Real Economic Averages
		(£/sh/d)	
8	1595—1620	2 (1) 6 2/12	1 (12) 8 8/9
9	1621—1636	2 (10) 0	1 (19) 6
10	1637—1700	2 (11) 0 1/3	—
11	1701—1764	2 (0) 6 12/32	1 (12) 0
12	1731—1740	1 (17) 3 1/2	—
13	1741—1750	1 (13) 9 1/2	1 (6) 8

By settling the problem of the development of corn-prices in a sound scientific way *Smith* was able to bring up an additional scientific argument, which is confirming his constatations by way of international comparison. For this purpose he has quoted several times the collections concerning corn prices in France published by *Messance* and *Dupré de St-Maur,* from which exactly the same tendency may be established, despite of differences in the economic conditions and the economic development of the two countries. They are fortifying his arguments not only by their close concordance, but "a contrario", too, with regard to the said differences in economic conditions and development.

The factual concordance had an utmost importance for the final conclusions, as several writers before *Smith* and also in his time interpreted these data and the factual development in silver value in the opposite sense: *Fleet-*

[11] *Smith,* op. cit., p. 148.

wood himself and several other authors, not designated by name,[12] were helding the view, that the value of the silver serving as currency was gradually diminishing from the 13th century on, despite the fact, that the continually falling corn-prices to the mid-16th century — even on the tiny statistical basis of the 7 groups or some 80—84 years — demonstrated a rise in the value of silver. Only from the mid-century of the 16th on, i.é. in the period 1561—1601 a rise first was shown in the silver value.

Smith has investigated the problem thoroughly from the economic side, too, and brought up several arguments on factual and theoretical economic basis. He was explaining that the main source of error in the interpretation of the interrelated corn-price and silver-value fluctuations was a widely spread hypothesis, — namely people supposed, that parallel with the advancement of economic development the quantity of the silver in circulation had accrued and in consequence its value ought to fall gradually. *Smith* explained, that the production of silver in Europe was not able to follow the economic take-off as its resources were slowly exhausted and the production methods became therefore gradually more unproductive. The discovery of America and especially the silver mines of Potosi in the mid-16th century has radically changed the situation, despite the fact that the influence of the inflow of American and Potosi-silver was later resented in England as in Europe. According to *Smith* the fall in silver value was marked only from the mid-16th century on and was more accentuated by the Potosi-silver from the 30-ies of the 17th century. — This is the result of his analysis of corn-prices as a statistics from secundary sources, and in close concordance with the data of French development, as shown by the publications of *Messance* and *Dupré de St-Maur*. Our figures calculated from mid-ranges are showing the influence of Potosi-silver even more marked than the downwards corrected real economic averages of *Smith* and are giving even more support to the Smithian argumentation.

No doubt the corn-price data for the last two full period (groups 10 and 11), i.e. the two 64-years span and their averages are the most convincing factual evidence concerning the rise of the corn-prices and the fall of the silver value, despite the presence of changes working against the main trend because of contrary movements on the commodity and money side of the interdependence given in the quantity-theory of money.

In the explanation of these modifying factors the Smithian analysis is an excellent one. It pointed out that the rise in the silver value from the beginning of the 13th century till 1570 was not only supported by the decreasing productivity of European silver-mines, but also by agricultural development. Agricultural products, especially the main corn products were produced during the economic take-off gradually with greater and more intensive labour and so their nominal prices were slowly rising. This secondary movement has led many writers to the above mentioned erroneous general interpretation of economic facts.

Between 1570 and 1636 the effect of the American silver import augmented the silver-supply in such an extent that it exceeded considerably its demand, despite the acceleration of economic growth on the whole European continent and especially in Britain. This development supported the fall in the real-value of silver and this tendency was maintained during a third period, i.e. from 1636 to *Smith*'s days. This trend was maintained among several disturbing factors on both sides, — on the commodity and on the money side.

On the commodity side the political upheavals represented by the Glorious Revolution (1648) and the introduction of corn export premiums in the interest of landed gentry (1688) helped to develop a corn-scarcity. So the real value of corn was higher than the free play of demand and supply would have enacted — without these disturbances. In *Smith'* expression it would have been surely lower, if the "average demand" and the "average supply" had been at work. Of course, the suspension of the corn-premiums had an offsetting effect and the bad harvests were reinforcing the scarcity-tendencies, generating positive or negative deviations from the "natural price" ensueing from the play of undisturbed free market conditions.

Here the creation of the two sub-tables for 1731—1740 and for 1741—50 (periods 12 and 13) deduced from the last period 1701—1764 (period 11) has its full justification. They are showing agricultural fluctuations ensueing from climatic conditions and from corresponding harvest results. These tables of *Smith* represent an early statistical venture into business cycles investigation and can not be highly praised enough. The deliberate choice of the 10 years time-span and the abandonment of the 12 years base of *Fleetwood* is demonstrating this purpose, corresponding approximately to the agricultural climatic cycle.

The Smithian analysis of the money-side movements is not less interesting. Here he mentions such autonomous factors as the wear and tear of silver coins and the clipping: factors diminishing the real silver-value. He quoted the calculations of *Lowndes*[12] according to which these two factors were reducing about 25% its real-value. Another factor influencing the fluctuations in the real-value in the opposite direction was given by the establishment and increasing use of the gold-standard and on this base a bimetallist currency system. *Smith* observed with very alert eye this interdependence in consequence of the latest recoinage of gold in 1695. Before it, according to *Lowndes'* data, "the price of silver bullion was seldom higher than five shillings and seven-pence an ounce, which is but five-pence above the mint price. But in 1695, the common price of silver bullion was six shillings and five-pence an ounce, which is fifteen-pence above the mint-price."[13]

Smith summarised the result of his investigations so, that because of the effects of the economic evolution and growth in general in the richest countries the real-value of silver is a decreasing one. Notably, the spread of wants is widening the volume of the necessaries and is augmenting the level of life, — but, of course, bad harvests and other political "calamities" may contrary this effect, even in spite of the suspension of the corn-premiums.

And once more he returned to the general problem with a remark of very far-reaching consequence, when he formulated his opinion with great accuracy and clarity as follows: "the increase in the quantity of gold and silver in Europe, and the increase of its manufactures and agriculture, are two events which, though they have happened nearly about the same time, yet have arisen from very different causes, and have scarce any natural connection with one another. The one has arisen from a mere accident, in which neither prudence nor policy either had or could have any share: the other from the fall of the feudal system and from the establishment of a government which afforded to

[12] Ibid., pp. 144, 148 and 158.
[13] Ibid., p. 155.

industry the only encouragement, which it requires, some tolerable security that it shall enjoy the fruits of his own labour."[14]

As a conclusion of this section we are inclined to say that the satisfactory economic solution brought up by *Smith* in this intricate problem, was considerably supported by his sound statistical reasoning, not only by the critical evaluation and technically faultless interpretation of the factual material, but also by the correct methodological application and by the carefully drawn conclusions. This solid inherent inductive basis — reinforced by the lessons of economic history — made it possible for the illustrious author to solve the main interdependence given in the quantity theory of money in a fair theoretical way, — despite of his rather hesitating attitude taken in the cardinal problem of value theory. We agree with the remark made by *J. A. Schumpeter,* that *Smith* elaborated several kinds of alternative value theories,[15] but in the problem of the real value of silver, he was very near to the labour-theory of value and this approximation helped him also considerably to detect the forces at work correctly, in opposition to the authors around *Fleetwood,* who were unable to interpret the inductive material in lack of appropriate theoretical guiding lines.

V.

By finishing my short paper I want to venture into the statistical theoretical interpretation of *Smith'* handling of statistical material and methodology as it is implied in his deliberations represented by the "Wealth of Nations". I find that the elements and the overall concept of a real statistical index-theory were present in his thinking, even if rudimentarily, especially in the analysis concerning the 17th and 18th centuries.

No doubt corn prices were approximated in his thought first as individual indexes developed as simple ratios of "earlier", i.e. "historical" prices at their "present or "base" values. This gives a rudimentary form of the Paasche-formula. To clean original data from fluctuations, the use of the mean value of the yearly spring and autumn quotations at Windsor market was applied in the numerator, and so the formula may be represented as follows:

$$I_{corn} = \frac{\frac{p_{0\,max_1} + p_{0\,max_2}}{2}}{p_1}$$

This is clearly a simple aggregative method and results correspondingly in a simple aggregative index. The index-character of the above formula was fortified by the help of economic practice and experience by substituting the "formal" or "notional" averages by real economic averages brought down from the maximal level to the economically mean-level with help of corrections by *Smith.* Representing this process in the formula and giving it an up-to-date form by multiplying with 100, we arrive at the implicit Smithian notion of index-numbers as follows:

$$I_{corn} = \frac{S(\bar{p}_{01} + \bar{p}_{02} + \bar{p}_{03} + \ldots + \bar{p}_{04})}{S\bar{p}_1} \cdot 100.^{16}$$

[14] Ibid., p. 192.

[15] *Schumpeter, J. A.:* History of Economic Analysis, Edited from Manuscript by *Boody-Schumpeter,* E., Third Printing, New York, 1959, p. 309.

[16] *Freund, J. E.:* Modern Elementary Statistics, Sec. Ed., Englewood Cliffs, 1960, pp. 111 and furth.

The role of averages in this line of thought has a cardinal importance, that was the reason why *Smith* dedicated so much care to elucidate their economic role and therefore he was anxious to establish homogeneity for the 17th and 18th centuries by creating a real arithmetic mean instead of notional or formal averages. His long passages recapitulating the guiding role of averages for the regulation of wages and prices from the time of *Edward III* on (1350), the establishing of the committees of "public fiars" in Scotland, elaborating the statutes concerning agricultural prices and wages, the so-called "assizes", are all examples for the regulation of corn- and ale-prices for a relatively long period.[17] These deliberations of *Smith* are all pointing into the direction that in British evolution the famous "common sense" created relatively early normal or average prices based on the arithmetic average and that the indexation of such evolution emerged consequently. These traditions are surely more deeply rooted there than in continental development, as already hinted at in connexion with economic and statistical literature.

These Anglo-Saxon traditions — it seems to be — had even a marked influence in the colonial American period, as by the creation of an aggregated real-index in the state Massachusetts in 1780 for similar purposes as formerly in Britain is demonstrated. This index incorporated four not weighted articles, — namely the prices of corn, beefsteak, wool and sole leather — and served to stabilize and adjust the payments of soldiers in view of the debasement of currency because of the war. This index was also from the methodological point of view a simple average of price relatives as the Smithian one, only the number of aggregations was augmented.[18]

The theory of index-numbers underwent a rapid development after the Smithian period in Britain and this process is already a better known part of the history of economic and statistical analysis. It seems enough to recall the names of *Playfair* (1786), *Suckburgh Evelyn* (1798), *Young* (1812), *Lowe* (1822) and *Poulett Scrope* (1833) and especially to underline the activities of *Newmarch* and *Tooke* in their big work (1838—1857), under whose direct influence "The Economist" introduced from 1869 in a continuous series the publication of the index-numbers of wholesale-prices in England.[19]

In all this development the pioneering exploits of *Smith* were surely playing a decisive role by preparing the economic thinking in the takeover of economic statistical factual material and the application of its more sophisticated methodology contributing thus to the spread of inductive scientific thinking in economic science.

[17] *Smith*, op. cit., p. 145.
[18] *Ulmer*, op. cit., p. 26, note (2).
[19] *Schumpeter*, op. cit., pp. 526 and furth.

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