

A Note
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Future Economist – A Dentist or A Mechanic?

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Abstract: In the following pages the author expresses his personal views on the role of an economist in modern society. He draws attention to the current debate over the state of economic science today and the loss of confidence not only in the competence of an economist but also in the wisdom of the science. He optimistically pleads for an all-round intensive teaching of economics in universities.

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Introduction

It remains an undisputed fact that Professor Alfred Marshall is a legendary figure in economic literature to who goes the credit for Economics became an independent academic discipline in university education throughout the world¹. His unending enthusiasm in struggling for the cause in the Cambridge University Senate and outside it was well felt. It was his Principles of Economics (1890) that made Economics a popular subject of study in the universities world over. Unfortunately, today just in less than a hundred years from its initiation, we are facing the crisis of economic science that is being loudly echoed in its criticisms like ‘economics is dead’, ‘economics is a useless unreliable science’ or ‘economists are incompetent people and poor specialists’.

The very first decade of the twenty first century is characterised with falling global outputs and increasing unemployment. The banking crisis, bail out of big industrial engines of growth and the declining consumption in Western economies in 2007-08 that triggered a deep global recession, also gave birth to a wide spread academic debate over the state of economic science and the role of an economist.

To the current economic situation and the pessimism in economic science, hopefully, John Maynard Keynes would have once again reacted in the same way as he did by repeating to his students his Madrid lecture of 1930². He said:

‘We are suffering just now from a bad attack of economic pessimism. It is common to hear people say that the epoch of enormous economic progress which characterised the nineteenth century is over; that the rapid improvement in the standard of life is now going to slow down...; that a decline in prosperity is more likely than an improvement in the decade which lies ahead of us...’

‘I believe that this is a wildly mistaken interpretation of what is happening to us. We are suffering, not from the rheumatics of old age, but from the growing pains of over-rapid changes, from the painfulness of readjustment between one economic period and another. The increase of technical efficiency has been taking place faster than we can deal with the problem of labour absorption; the improvement in the standard of life has been a little too quick; the banking and monetary system of the world has been preventing the rate of interest from falling as fast as equilibrium requires.’

‘The prevailing world depression, the enormous anomaly of unemployment in a world full of wants, the disastrous mistakes we have made, blind us to what is going on under the surface to the true interpretation...of the trend of things. For I predict that both of the two opposed errors of pessimism which now make so much noise in the world will be proved wrong in our own time – the pessimism of the revolutionaries who think that things are so bad that nothing can save us but violent change, and the pessimism of the reactionaries who consider the balance of our economic and social life so precarious that we must risk no experiments.’

‘...do not let us overestimate the importance of the economic problem, or sacrifice to its supposed necessities other matters of greater and more permanent significance. It should be a matter for specialists like dentistry. If economists could manage to get themselves thought of a humble, complete people, on a level with dentists that would be splendid!’

Today, I very much endorse the above statement of Keynes with a minor change in his vision of specialists i.e. economists might one day be thought as humble competent people, on a level with dentists. Note, since then, fluoridation, better oral health, and sealants have contributed to reductions in the demand for, and the supply of dentists. Can we hope for such preventive breakthroughs in economics?

What I want to address here is as to what duties the economists in future are supposed to perform and what sort of economics education will be required for them?

Let me remind that during the last quarter century, on one hand, to no ones surprise, the classical teaching of economics slowly started withering away even in the most prestigious universities and on the other in the US, Europe and Asia in 1990s and 2000s there was a strong surge in admissions to the Business Schools at the cost of Economics.

Sadly enough, economic science is ailing today. As the doubts in the forecasting accuracy of economics grew, the interest of researchers in general economics gradually declined. Inside company research became popular. Moreover, the scepticism of 1980s grew and engulfed the entire economic forecasting activity. Many companies disbanded their forecasting units and independent forecasting economic consultancies withered away. Economics as a science was branded 'unreliable' and the economists as 'poor'. Naturally, after twenty or so years we are asking ourselves as to what has happened to economics. My quest for answer takes me back to the history of philosophical and economic thought.

The State of Economic Science

Since 1990s, the confidence of American, Japanese and West European corporations in the economic forecasts has been badly shaken. Because even with the help of computerised models, the economists failed to foresee the stagflation of the 1970s and the cyclical trends of the 1980s. The confidence further depleted in the usefulness of economics as a science for the experts did not accurately predict the consumption pattern of the households or the firms. In the mid 1990s some big multinationals in the US started firing their 'crystal bowl watchers'³. The Swedish Academy of Sciences too recognised this shifting course in Economics by awarding the 1990 Nobel Prize in Economics to Harvey Markovitz, Merton Miller, and William Sharpe.

The macroeconomic models of the 1930s were based on consumption and saving/investment equations. The year following the WWII, were the 'golden years' for such models. For two decades the world recorded high economic growth rates, but in the 1970s the high hopes were watered down when these models could not foresee the repercussions of the explosive hikes in oil prices. The mainframe computers were fed with 'known' and 'unknown' parameters to produce equations that could be used in justification of proposed growth policies. One worthy author of such models Lawrence Klein won a Nobel Prize for his models in 1980. These models were designed to simulate faster sustained economic growth of the national economies⁴.

The current economic situation too has placed economic science in a delicate situation. In past three years it has provoked a lack of confidence in validity of its theories. It is being said that few economic bubbles have burst more spectacularly than the reputation of Economics as a science. In the wake of biggest economic

shake-up in 80 years its reputation has taken the beating. While Paul Krugman in 2008 in his LSE lecture argued that much of the macroeconomics of the past 30 years was ‘spectacularly useless at best and positively harmful at worst’; Barry Eichengreen went on to say that current economic turmoil has ‘cast in doubt much of what we thought we knew about economics’.

Two central parts of the discipline – macroeconomics and financial economics – are now being put to serious re-examination. The attack is directed on three major fronts: that macro and financial macroeconomics helped cause the banking crisis, that it failed to foresee and stop it, and that economists have no idea how to fix it.

While the economists, especially in the central banks, were too fixated on taming inflation and too brave about asset bubbles; financial economists formalised theories of the efficiency of the markets, fuelling the notion that markets would regulate themselves and financial innovation are always good. Macroeconomists also had their blind spot. Their standard models assumed that capital markets work perfectly. By assuming that it is so, they were largely able to ignore the economy’s financial plumbing. The models that ignored finance had little chance of spotting a calamity that stemmed from it.

The Keynesian task of ‘demand management’ outlived the Great Depression, becoming a routine duty of governments. They were aided by economic advisers who built economic models and were guided by apparent trade-off between inflation and unemployment. But their credibility did not survive the oil price shock of the 1970s and western economies were deposed to stagflation – a situation which the Keynesian consensus grasped poorly and failed to prevent.

The mainstream macroeconomics embodied in dynamic state general equilibrium models was a poor guide to the origins of financial collapse. The conventional instruments of monetary policy proved insufficient. Today, some economists advocate a bold fiscal expansion. Evidently, economics requires a revolution in techniques. Macroeconomists should turn to patient empirical spadework, documenting crises past and present, in the hope that a fresh theory might later make sense of it all.

On the other end, in financial economics, the efficient market hypothesis strategists claimed that their approach made the financial system healthier and safe. This is why many people view the financial crises that began in 2007-8 as a devastating blow to the credibility of banks but also of the academic discipline of financial economics. The banks assumed that they can always rollover their short-term debts or sell back mortgage backed securities. The financial failures made a mockery of both these assumptions. Funds dried up and the markets thinned out. What followed was a serious rush for cash.

Macroeconomists split – into purists and pragmatists – drawing opposite messages from the episode. The purists blamed the stagflation on restless central

banks trying too hard and the pragmatists that markets malfunction, wages fail to adjust and prices are sticky. For two decades after 1982 the two schools converged into the ‘new synthesis’ that flowed from universities to central banks. It underlay the doctrine of inflation targeting.

The fragile consensus of monetary/fiscal policies has now been blown apart. With their compromise tools useless, both sides have retreated to their roots. Keynesians have become uncritical of fiscal stimulus; and even with zero short term interest rates and banking troubles on hand monetary policy works less well. Naturally, there is a clear case for reinvention. Just as the Great Depression spawned Keynesianism, stagflation of 1970s fuelled monetarism, creative destruction is underway. Although the current economic depression has exposed bitter divisions among economists, many people in the profession do believe that it could still be good for economics.

I would also add that the troubles of economic science are purely methodological issues and it is in this context that these should be addressed. The general technique to study the works of economists and philosophers which develop, apply, and discuss the theory is to rely on the tentative results of contemporary economics and on initial judgments concerning the nature and worth of economic theory and economics as a discipline. Economists talk about their own work in many ways. They write, for example, about ‘principles’, ‘models’, ‘theories’, ‘assumptions’, and ‘definitions’ and make use of previous work by epistemologists and philosophers of science. An economic scientist studying economic theory is in the same philosophical position as any empirical philosopher of science seeking knowledge of sciences. Economists need to trim, revise, and even invent philosophical categories in trying to make sense of economic theory. We should acknowledge that the discussions of economic issues are often biased and distorted because of their importance to interests of individuals and social groups. Economists can, however, address a broader audience and a wider spectrum of issues if they do not start by taking them as the paradigm for what economics should be. Economics must thus struggle to avoid becoming apologetics for any school of economics.

History is a witness that, usually, the business cycles have been followed by the reassessments of the economic science. Deep recessions have been followed by negation of the existing orthodoxies giving way to the new. As more than over a century ago, as now, economists seemed to feel that the glaring lack of consensus on fundamental principles compromised the scientific status of Economics, and there were strong professional and public pressures to establish a new orthodoxy that could speak authoritatively on economic matters.

Should an Economist be a Dentist or a Mechanic?

I must mention here that on this issue my views as expressed below are deeply influenced by three famous economists who taught me and became my professional friends later in my life: Sir Hans Singer a student of Schumpeter (at Bonn) and Keynes (at Cambridge); Paul Streeten, educated at Oxford and Amartya Sen, educated at Cambridge.

First, let me ask ourselves: Who is an economist? What he does? Is he someone a social ‘philosopher’ like Adam Smith or an analyst and teacher like Alfred Marshall or a ‘dentist’ of Keynes’s dream? It seems to me that modern economist is none of the said sort. He is someone – with a little bit of everything – a theoretician, observer/researcher, analyst, diagnoser, policy designer and sometimes who gets involved in policy implementation. My mentor Jakov Sirotković at Zagreb often used to tell that an economist is someone who is capable of studying, analysing and planning of ‘totality of productive relations’. Evidently, such a figure naturally would have to be an intellectual giant.

Keynes in his remark on the role of the future of economists seems rather sceptic as he thought that economists ‘could manage to get themselves thought of a humble, complete people, on a level with dentists’. If so, ‘that would be splendid!’ Alas, after seventy years, today, economists have either been reduced to a pure theorist – some academics caged in prestigious university campuses, some receiving the Nobel Prize in Economics for their theoretical contributions, or a massive number young people holding graduate degrees in economics and working for the state or private employers. Except a few, to our regret, the vast majority is neither well averse with real economics nor is able to use the acquired knowledge in appropriate manner. Professional economists have been to their desks doing some routine statistical analyses of little use. Evidently, we have not reached anywhere close to Keynes’s dream.

I personally would like to see my fellow economists of the future in the role of a mechanic – knowledgeable, well-equipped with plenty of analytical tools in his ‘tool-box’, capable of fixing the defects in economic machine (system)⁵. I see him well aware of economic doctrine, finance, economic history and philosophy. I see him talented in understanding the socio-psychological reactions of the people in face of economic trends, and capable of using appropriate analytical tools. Since, the economic system by nature is prone to frequent breakdowns and cyclical fluctuations, his role as constructor and repairer is of utmost priority. For such a role, I visualise an apprenticeship in places where economic policy is evolved.

To begin with, let me mention that we do not require an army of economists. Thus, there is no need to enrol a massive number of students in the universities. Educating an economist⁶ of the needed type is not going to be an easy task. While the students

will have to be gifted, the teachers would have to be highly qualified and competent and curriculum tough. Now, let us not be misled by Keynes's remark that 'the study of Economics does not seem to require any specialised gift of an unusually high order'⁷. I would like to cite and agree with him when he writes in his essay on Alfred Marshall:

'Is it not intellectually regarded a very easy subject compared with the higher branches of philosophy and pure science? Yet good or even competent, economists are the rarest of the birds'. He further adds, '...the master economist must possess a rare combination of gifts. He must reach a high standard in several different directions and must combine talents not often found together. He must be mathematician, historian, statesman, philosopher – in some degree. He must understand symbols and speak in words. He must contemplate the particular in terms of the general, and touch abstract and concrete in the same flight of thought. He must study the present in the light of the past for the purpose of the future. No part of human nature or their institutions must lie entirely outside his regard. He must be purposeful and disinterested in a simultaneous mood; as aloof and incorruptible as an artist, yet sometimes as near the earth as a politician.'⁸

I see education as a complex process. As a teacher, I am inclined to believe that education is not only acquiring skill or aptitudes, but it is also about acquisition of attitudes. People need to know not only methodology, but also reality and should be problem/solution driven. They should know the scope as well as the limits of techniques they learn.

Greek philosophers have long back recognised the importance of education of the people. Modern economics, in pioneering work of Theodore Schultz has recognised the significance of the role that education plays in economic development of a country. Question is what type of education? General or specialised, scientific or skill-oriented, intermediate or higher university education should be provided. From a country's perspective and its future, all types of education facilities need to find proper place to suit the public choice. But, at all levels and for every science/art there must be the right type of education. This, moreover, depends upon the choice of curriculum, length of study, intensity of learning, quality of teachers and institutional facilities, etc.

In the 1980s, voices were uttered loudly that 'one who is only an economist is a poor economist'. The pressure for jobs, promotion, tenure and publication in the US and UK universities grew such that the economists had to 'cultivate ever narrower fields' and in the academia 'publish or perish' was the course. The result was that the economics students were trained to become 'narrow specialists' without understanding the institutions, the economic thought, the economic literature, the

handling and evaluation of quantitative and qualitative data, learning to weigh evidence, and without wider visions.

Lately, with the reform of the education system within Europe, the so called Bologna Process is asking for major changes, including the curriculum. At least in the domain of Economics, questions are being constantly posed: how much of what content to be provided, interdisciplinary or specialised education, should mathematics be compulsory or not, should the degrees be oriented to theoretical knowledge or to applied skills, etc.? Here are some of my views in the light of these issues.

The Content of Economics

As we know, Professor Alfred Marshall seems to have created the gross content of Economics of the last century. He taught Economics at Bristol, Oxford and Cambridge. To my mind he deserves due credit for (a) making Economics completely independent of the Moral Sciences, (b) broadening the contents of economics, and (c) educating leading economists of the future (like D H Robertson, John Neville and John Maynard Keynes, Joseph A Schumpeter, Gustav Cassel, Irving Fisher, E R A Seligman, R W Taussig, Charles Gide and W R Sorley) who will have an immense impact on the future of economics in the US and Europe.

Although, Harvard, Yale and Columbia universities in the US had already established Departments of Economics and Social Sciences much earlier, Cambridge and Oxford in the UK had to wait until 1903 when Professor Marshall got his way in getting approved by the University Senate a separate Tripos Degree in Economics, after a long fight lasting since his joining as a Professor of Political Economy at Cambridge in 1885. At that time, the subject was taught formally for both the Moral Science and History Tripos and accounted for a little less than one-third in the moral sciences.

At Cambridge, Alfred Marshall had opposed every effort to subdivide economic studies into theory, history and policy and he carried his struggle of independence of Economics from Moral Sciences successfully. In 1902 he stressed the need of economics education arising from growing complexities in business, the need in labour relations for the training of 'sympathies and intellect' which economic studies provide, and for wider education on social questions such as housing, charity and the causes of unemployment. He considered 'reasoning, perception and observation, and possession of a scientific imagination' as the three basic requirements of study of economics⁹.

Since J M Keynes published his General Theory of Employment, Interest and Money (1936), Economics education in the Western world, particularly in the US,

has moved far away from these types of skills. Many distinguished economists in 1991 agreed that in graduate (master) education ‘tools’ and ‘theory’ is preferred at the cost of ‘creativity’ and ‘problem solving’. It was also noted that graduate students who come from other fields can get Ph.D.s with little or no knowledge of economic problems and institutions¹⁰.

To me, it seems that time has come to reverse the trend. In the light of the above observation, I believe that it would perhaps be right to sacrifice some technical aspects of economics (including mathematics) in favour of disciplines like political science, philosophy and economic history.

Philosophy consists of logic, epistemology, moral and political philosophy. A sound knowledge of logic and theory of knowledge will make the economist not only a good theorist but also teach him to distinguish between, on one hand, tautology and deductions from them, and on the other, empirical facts and their relation. Economics suffers from mistaken validity for truth and the easy transition to falsehood that lies at the alleged rigour and precision of mathematical economics. Conclusion may be valid but untrue.

Similarly, a good education in moral and political philosophy (political science) would avoid or at least reduce the numerous hidden biases in economic reasoning. The knowledge of political institutions and processes makes the economist aware of the constraints and opportunities for getting policies right. The economists need to take their investigation into the political variables in economic policy, and supplement positive with normative political economy.

Further, social, political and economic history is deeply neglected in modern economic education. It hardly needs any argument of defence.

Does this broadening not mean that we have to sacrifice some education in economics that is all the time becoming more and more technical, specialised, fragmented and professional? I am afraid that unless we lengthen the time of study, evidently, some sacrifices in curriculum will have to be made.

Specialised Education

As far as the question of specialised economics education is concerned, it is said that the specialist knows more and more about less and less until he knows everything about nothing. The real question is should a well-trained economist deal with few areas or spread his investigation widely? I feel that it should be left to individual choice.

A widely held criticism of modern American education of economics¹¹ is that it has, unfortunately, become too narrow and too far from reality¹². The economics departments in universities are awarding degrees to generations of idiots savants,

brilliant at esoteric mathematics yet innocent of actual economic life¹³. British and European education of economists with the growing popularity of business studies is slowly moving on a similar path.

I would rather agree with Paul Streeten and favour 'being a broad-gauged economist and vaguely right to being precisely wrong'. Economics is not a science in which controlled experiments can be conducted and no economic theory has ever been falsified by an experiment.

Mathematics and Economics

Many of us would agree that mathematics is a language of expression. Therefore, hardly there can be an objection to its use wherever appropriate. The only concern could be that the users of it should know its limitations as well as its scope¹⁴. From its beginnings economics has been couched in formal arguments over the issue.

It is often claimed that the virtue of mathematics is that assumptions, deductions and conclusion are spelt out precisely, whereas descriptive economics permits fuzziness. But fuzziness enters into mathematical economics when a, b, c are identified with individuals, firms, and equipment. The identification of the precise symbol with often fuzzy reality creates lack of precision and blurs the concept.

Correct inference from clearly stated premises leads to valid conclusions. There are two dangers of the over use of mathematics with which economics is known to suffer. One is that validity can be mistaken for truth as the deductions from analytical models can be taken as descriptions and analyses of the real world. The other is that time and effort devoted to extract theorems can be at the expense of investigation of real events.

British economists of the pre World War II era had expressed their reservations regarding the over-use of mathematics in economics. Both Alfred Marshall and J M Keynes (mind that the latter was well trained in mathematics), were fairly sceptic about it. Alfred Marshall in his letter to A L Bowley and J M Keynes in his General Theory write about the issue.

To quote Alfred Marshall:

'In my view every economic fact whether or not it is of such a nature as to be expressed in numbers, stands in relation as cause and effect to many other facts, and since it never happens that all of them can be expressed in numbers, the application of exact mathematical methods to those which is nearly always waste of time, while in the large majority of cases it is positively misleading; and the world would have been further on its way forward if the work had never been done at all.'¹⁵

In his another letter Alfred Marshall writes:

‘I had a growing feeling in the later years of my work at the subject that a good mathematical theorem dealing with economic hypotheses was very unlikely to be good economics: and I want more and mire on the rules – (1) Use mathematics as a shorthand language, rather than as an engine of inquiry. (2) Keep to them until you are done. (3) Translate into English. (4) Then illustrate by examples what are important in real life. (5) Burn the mathematics. (6) If you can’t succeed in (4) burn (3). This last I did often.’¹⁶

J M Keynes expresses his view by stating that

‘...symbolic pseudo-mathematical methods of formalising a system of economic analysis...allows the author to lose sight of the complexities and interdependencies of the real world in a maze of pretentious and unhelpful symbols.’¹⁷

Why is increased dominance of mathematics in economics? Frank Hahn blames Milton Friedman’s ‘as if’ doctrine and the romantic desire to pass as a scientist.¹⁸ At the end of the 19th century, with the so-called ‘marginal revolution’, mathematics was increasingly introduced in Economics by Leon Walras, Augustin Cournot, Stanley Jevons, Arthur Cecil Pigou, F Y Edgeworth and others to make it more like physics, and raise its status. Since then and particularly after 1950s it has come to dominate the subject.

In the post-war years many distinguished mathematical economists have won Nobel Prizes in Economics. From Jan Tinbergen and Ragner Frisch to Simon Kuznets, Kenneth Arrow, Gerard Debreu, Lawrence Klein, Edmund Phelps, and Wassily Leontief have all been critical of the abuse and excessive use of mathematics¹⁹.

However, let us not forget that their criticism is directed towards the triumph of technique over substance, of form over content, of elegance over realism. Mathematics should be the servant and not the master of economics. No doubt that every economist must have a training in mathematics else he would not be able to see through the flawed reasoning.

Economics Curriculum

With the Bologna reforms of the European university education system, as mentioned above, a debate regarding the curriculum is continuing. Among the

academic staff there is a wide spread concern on the quality of education that is resulting in the reform process.

Now, let me give away some of my thoughts on the issue. Personally, I strongly believe that our future Economist should master at least the following disciplines: philosophy, intermediate mathematics, political science, social psychology, economic history, economic thought, monetary economics and finance, macro- and microeconomic analysis. Further, he should also master methodological subjects such as econometrics, data analysis and model simulations. Finally, I would love to see my fellow economist who prefers to read original writings (books and professional journals) and to be able to write rather than be dependent on the internet and copy/cut and paste.

Once, a candidate has received his academic degree, should compulsorily be required to undergo specialization in an institution with a programme similar to the residency for the medical graduates.

Conclusion

Economics, today, definitely is under transformation. To me personally the current state of graduate education of Economics in most universities world-over seems in a delicately poor state. Although, Alfred Marshall got Economics the recognition of being an independent 'social science', its position was only strengthened by the introduction of mathematical and geometrical tools, and analytics used by F Y Edgeworth, J R Hicks and A C Pigou. Economics of the post-war years on both sides of the Atlantic, particularly in the US, under the influence of works by Paul Samuelson, Kenneth Arrow, Laurence Klein, Robert Solow, Wassily Leontief and other mathematical economists, this 'social science' was turned more into a 'technical science'. Unfortunately for Economics, the employment successes of business school graduates in the US had cast a shadow on its teaching and learning. Moreover, the irony is that the US Business Schools employ the best Economics faculty.

Economics of Adam Smith as a 'social science' has indeed come a long way. What remains at a loss is that the trained economists have lost touch with the reality of daily economic life and the institutions. To the surprise of many not even a sound technical knowledge of methods is of any great help to solve the real problems of economic growth, employment, inflation, recession etc.

Thus, the task for us all ahead: An improvement in the quality of Economics education, through multidisciplinary of courses and intermediate mathematics.

NOTES

¹ P Groenewagen (1995), *The Soaring Eagle: Alfred Marshall 1842-1924*, : Cheltenham: Edward Elgar.

² 'Economic Possibilities for our Grandchildren', (1930) included later in his (1931), *Essays in Persuasion*, New York: Norton, 1963 pp. 358-373.

³ General Electric, a giant corporation that earned revenue of some 70 billion in 1996 did not employ even a single economist, IBM fired its 'team of economists' in favour of good 'portfolio and risk managers', because as one spokesperson said, 'it is much cheaper for us'. Soon company experts became more concerned with risk management, watching financial derivatives, hedging against price and interest rate fluctuations, inventory management, etc.

⁴ Note that using such models in 1974 the Economic Council of the President of the United States enthusiastically overestimated the economic growth for 3 per cent and underestimated inflation by the same percentage.

⁵ Economic system should be understood as a compound of institutional framework including economic legislation, economic structure of the society and economic policy of the state.

⁶ I mean here graduate (master) and postgraduate (doctoral) education of 'economists' only.

⁷ Keynes, J M, 'Alfred Marshall' in his *Essays in Biography*, London: Macmillan (1972). This remark should be taken in context to the then prevailing widespread feeling among the university students and the public that the study of economics, compared to other sciences or law, does not require any pre-requirements and is easy to complete.

⁸ *ibid.*

⁹ Marshall, A (1902) 'Economic Teaching at the Universities in Relation Public Well Being', paper presented at a Conference of Members of the Committee on Social Education, London, pp 3-9.

¹⁰ See Krueger, A et. al., *JEL*, Vol. XXIX, No.3 Sept. 1991, pp 1035-1053.

¹¹ Streeten, Paul (1990), 'American Economics Education', mimeo

¹² Klammer, Arjo and David Colander, (1990), *The Making of an Economist*, Boulder: Westview Press.

¹³ Kuttner, R (1986), 'The Poverty of Economics', *Atlantic Monthly*, February Issue, pp 74-84.

¹⁴ Famous American economist Kenneth E Boulding in his article 'Samuelson's Foundations: The Role of Mathematics in Economics', published in the *Journal of Political Economy*, June 1948, pp. 187-209 has said that 'I know of no mathematical expression for the literary expression 'I love you''. In 5th Annual Kenneth Parsons Lecture Series, in his lecture 'Economics as an Institution' delivered at IBS, Boulder, Colorado on March 8, 1989 he reiterates, 'Mathematics is a language – or perhaps we should say a jargon – with an extraordinary paucity of verbs – it is hard to think of more than four: equals, is greater than, is less than, and is a fraction of'.

¹⁵ Quoted in Pigou, A C (ed.)(1966), *Memorials to Alfred Marshall*, London: Kelly, p. 422.

¹⁶ *Ibid*, p. 427.

¹⁷ Keynes, J M (1936), *General Theory of Employment, Interest and Money*, London: Macmillan, pp. 297-298.

¹⁸ Hahn, F (1994) 'An Intellectual Retrospect', *Banca Nazionale del Lavoro Quarterly Review*, p. 246.

¹⁹ In his presidential address to the AEA meeting in 1970, Wassily Leontief condemned the misuse of mathematics by commenting: 'preoccupation with imaginary, hypothetical, rather than with observable reality.' In a letter to *Science* magazine he wrote, 'Page after page of professional economic journals are filled with mathematical formulas leading the reader from sets of more or less plausible but entirely arbitrary assumptions as to precisely stated but irrelevant theoretical conclusions.' (Quoted by Kuttner, R op. cit. 1985). It is interesting to mention that as a good empirical analyst Wassily Leontief investigated the *American Economic Review*. He found that 54 per cent of articles were 'mathematical models' without any data. Another 22 per cent drew statistical inferences from data generated for some other purpose. Another 12 per cent used analysis with no data. Only one half percent used direct empirical analysis of data generated by its author.

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