



JOHN HAJNAL

John Hajnal

1924–2008

Introduction

JOHN HAJNAL was born on 26 November 1924 in Darmstadt, a town close to Frankfurt, which was then in the German State of Hesse. His full name was John Hajnal-Kónyi, reflecting the family's Hungarian background. The family was also Jewish, and with increasing discrimination and persecution during the Nazi regime it decided to leave Germany. John was sent to a Quaker school in The Netherlands in 1936. A notable linguist, he became fluent in Dutch and later in life would sometimes lapse into Dutch. He described this as the happiest time of his life (Seneta, 2010). His parents left Germany for England and John rejoined them in 1937. He then attended University College School in Hampstead, London, and entered Balliol College, Oxford, at age 16. John was highly academically talented and was also multilingual. Initially he studied classics, but switched to politics, philosophy and economics in his second year and gained a First Class Honours degree in 1943.

Although without an academic background in statistics or mathematics, he had a strong interest and flair for these subjects and was a member of the staff of Britain's Royal Commission on Population in the period 1944–8. During that time, he contributed to the work of the Commission but also started to develop his wider interests in demography, which led to a number of publications in the premier journal in the discipline, *Population Studies*, and elsewhere, including the *American Sociological Review* and *Population Index*, in the late 1940s and early 1950s. At the same time, two demographers who were to play important roles at the

London School of Economics (LSE), David Glass and Eugene Grebenik, were also working with the Commission.

Although relatively young, his contribution to the work of the Commission was well recognised and he was recruited to work on demography at the UN in New York (where he met his future wife Nina) by Frank Notestein, who was the first director of the UN Population Division. He stayed at the UN from 1948 to 1951, but then moved to Princeton University when Frank Notestein, who had been on leave from his post as Director of Office of Population Research (OPR) at Princeton University, returned. Frank Notestein was one of the fathers of demographic transition theory and he attracted a number of distinguished scholars—the calibre of staff that he recruited included Irene Taeuber, Frank Lorimer, Dudley Kirk, Kingsley Davis, Robert Potter, and Charles Westoff, indicating the standing of John Hajnal at that time. He spent the time there not only working with Notestein but he also, importantly for his future development, spent considerable time in developing his mathematics skills (William Feller was at Princeton during John Hajnal's 1951–3 period there). The family then returned to England, where John took up a post in the Department of Social and Preventive Medicine at Manchester University in 1953. John Hajnal was influenced and encouraged by the probabilists Maurice Bartlett and Walter Ledermann during his time at Manchester.

The family moved to London in 1957, when John obtained a lectureship at the London School of Economics. John was recruited by LSE principally as a demographer, but over time his interests increasingly turned to theoretical statistics. He was promoted to Reader in 1966 and to Professor of Statistics in 1975. He became an elected member of the International Statistical Institute (ISI) in 1961 and a Fellow of the British Academy in 1966. He retired from the LSE in 1986, although he continued contact with the institution both socially and intellectually; he was still publishing papers with members of the Statistics Department in 1999.

Since he had both substantive interests and strong statistical technical skills, he was able to attract research students with interests that overlap these two areas. The most notable was probably Bill Hamilton who became a major figure in evolutionary theory, producing a number of key findings including the kinship coefficient of altruism. Bill Hamilton transferred from Cambridge to be supervised by John Hajnal and Cedric Smith of University College London (UCL), apparently because Ronald Fisher was regarded there as a 'mere' statistician. However, Hamilton did not feel

entirely at home in his new environment and after a year transferred to UCL. Norman Carrier appears to have been the member of staff who left the greatest impression from his time at LSE (Hamilton, 1995, pp. 3–4).

John Hajnal's teaching at LSE concentrated on theoretical statistics, especially in actuarial mathematics, although his most influential research work is in demography. He was a member of the Statistics Department and there was very little overlap with the postgraduate M.Sc. Demography courses that were mainly taught by a group of specialist demographers—David Glass, Norman Carrier and Chris Langford.

In his time at LSE, a number of developments took place in demography. Under the leadership of David Glass, who was then the foremost scholar in the discipline in the country, funding had been obtained from the Ford Foundation to set up an M.Sc. in Demography from 1965–6 (Langford, 1988). LSE also housed the Population Investigation Committee (PIC), members of which, especially David Glass, had been responsible for undertaking much of the work of the Royal Commission on Population. The PIC continued its activities, including organising a number of large-scale studies such as the 1946 Birth Cohort Study (NSHD: Wadsworth, 2010) and later studies such as ones on birth control and fertility in Great Britain (e.g. Langford, 1976). The PIC also publishes the journal *Population Studies*. However, John Hajnal played little role in these activities; he was never a member of the editorial board of the journal although he was a frequent contributor to book reviews not only in *Population Studies* but in other journals as well.

Although he served as member of the PIC for a number of years, he does not seem to have been active in the Committee or in the establishment of a number of major initiatives at the time. David Glass was setting up a large-scale demography training programme and running the PIC. Bill Brass at the London School of Hygiene and Tropical Medicine was devising new methods for measuring fertility and mortality in countries with poor data collection systems and also building up an active research centre. Tony Wrigley and Peter Laslett at Cambridge were founding the Cambridge Group for the History of Population and Social Structure (HPSS) as well as writing books for the wider informed public, such as *The World We Have Lost* (Laslett, 1965), which appeared in the same year as John Hajnal's most famous paper on European marriage patterns (Hajnal, 1965), and *Population and History* (Wrigley, 1969). Although he did not play a prominent role in major scientific congresses and learned societies, Hajnal built up a series of links with scholars with overlapping interests in a number of institutions. He made frequent visits to Cambridge

to discuss work with members of HPSS, including Peter Laslett with whom he had a close relationship even though they had very different personalities, and other scholars with overlapping interests such as Jack Goody and Alan MacFarlane. His periods of study leave included Visiting Fellow at Trinity College, Cambridge, OPR at Princeton (where he wrote his 1982 paper) and Rockefeller University, New York, where he collaborated with Joel Cohen. We now summarise his various contributions to scholarship.

Demographic Modelling

Population projections in practice and in theory

John Hajnal had started work at the Royal Commission on Population in 1944. The Commission had been proposed in 1936 when there was substantial concern about population decline—a book by Enid Charles, the wife of Lancelot Hogben, one-time professor of Social Biology at LSE, *The Twilight of Parenthood* (Charles, 1934) had suggested that the British population might fall substantially. If the recent trend in Sweden occurred there too, the population of England and Wales would fall by 90 per cent to about four million over the next century (Charles, 1938). The establishment of the Commission was interrupted by the Second World War and it did not formally gain approval by Royal Warrant until 1944. John Hajnal was well placed with his quantitative skills to contribute to its work. In his time there, together with Bryan Hopkin, a life-long friend who was Assistant Secretary to the Commission and later became Chief Economic Adviser to the Treasury and Head of the Government Economic Service, he undertook the first large-scale and systematic set of population projections for Britain. In the past methods for doing so had been based on procedures for which the justification was unclear. However, in the 1930s models using matrix algebra were developed by scholars like Whelpton and Leslie. These provide a coherent way for incorporating assumptions about the components of population change and showing the implications of these in both the short and the long term. The work involved in making projections was time-consuming given the limited technology available at the time for undertaking the substantial number of calculations required. Nevertheless, John Hajnal produced a set of sixteen alternative projections which formed the basis for much of the debate about trends in the post-war period (Royal Commission on Population, 1950).

These population projections used different combinations of assumptions for fertility, nuptiality and migration (mortality, which was a topic that John Hajnal showed little interest in, received less attention).

Fertility was assumed to depend on marital status, age and time married. This model, with a particular emphasis on marriage as a key variable, was therefore more complex than ones often used today (a similar approach incorporating marriage explicitly was adopted in British official population projections in the 1960s, but was abandoned when the projections were found to be of poor quality). The alternative assumptions covered what were regarded as a range of plausible scenarios. There was no preferred (or 'central') projection identified. The projections were produced for a 100-year horizon starting from a base population of 48.2 million in 1947. For 2007, the GB projected population values ranged from 39.8 to 57.0 million. The actual 2007 official estimate turned out to be 59.2 million. Thus the projections that were made underestimated population growth in the rest of the century for reasons relating to each of the determinants of population change—fertility, migration and mortality:

1. the reversal of the long-term decline in fertility of earlier decades and the emergence of the so-called post-war 'baby boom' was unexpected;
2. there was a change in international migration whereby Britain ceased to be a net exporter of people mainly to the Commonwealth and became a net importer of people from parts of the same area; and
3. mortality improved more than anticipated, leading to greater than expected numbers of older people.

However, the importance of this work was in developing a coherent framework for discussion about future scenarios rather than its accuracy (all projections will turn out to be wrong), a point John Hajnal was to elaborate in his later 1955 paper.

Hajnal's work showed that some of the more alarmist projections of the pre-war period, such as by Enid Charles, were based on implausible, over-simplified models and that it was highly unlikely that there would be rapid population decline. In fact, population started to increase during the 1950s as fertility increased from the mid-1930s low point of 1.72 in 1933 to a maximum value of the total fertility rate (TFR) of 2.93 children per woman in England and Wales in 1964—although, as discussed later in the section on population models, John Hajnal would have been sceptical of this most conventional and widely used measure as a reliable indicator

of the 'level of fertility'. However, the fact that there was a substantial rise in fertility in many developed countries in the post-war period was not in dispute. The issue of over-population had not yet become a topic of interest and indeed many saw population growth as a positive trend in contrast to the conditions of the pre-war depression years. Public and policy interest waned, only to reappear a decade later when the implications of rapidly growing populations in both developed and developing countries became a topic of major concern, but by that stage John Hajnal had moved on to other interests.

Population projections in theory

John Hajnal had been directly involved in the production of the first major set of 'modern' population projections in Britain. The methods used directly modelled the demographic processes by which populations change—births, deaths and migration—so permitting use of specialised insight and experience of the individual components and allowing the relative importance of these factors to be assessed. However, that work also made John Hajnal sceptical about over-extending the limits of forecasting. He presented a paper entitled 'The prospect for population forecasts' at the 1954 World Population Conference in Rome, which was published in the proceedings of the conference and an expanded version in 1955 in the *Journal of the American Statistical Association (JASA)*. Hajnal's main arguments were: '(1) that population projections in the future as in the past will often be fairly wide of the mark—as often as simple guesses would be; (2) that, nevertheless, the frequent preparation of projections will continue; (3) that a projection can be useful as a piece of analysis even if its accuracy is low; (4) that simple, unpretentious short term projections should be used to meet most practical needs for population forecasts; (5) that greater flexibility and variety in techniques for projecting births need to be developed'. He finished by stating 'If there is a general lesson to be drawn from all this, it is, I think, first that as little forecasting as possible should be done, and second that, if a forecast . . . is undertaken, it should involve less computation and more cogitation than has generally been applied. Forecasts should flow from the analysis of the past. Anyone who has not bothered with analysis should not forecast. The labor spent in doing elaborate projections on a variety of assumptions by a ready-made technique would often be much better employed in a study of the past. Out of such study may occasionally come important insights about unexpected possibilities in the future' (Hajnal, 1955, p. 321).

Unlike his earlier empirical work, this was a reflection on his own and others' work in the area. The statement about the relative importance of cogitation and computation resonated with Louis Henry with whom John Hajnal corresponded following publication of the paper. Henry wrote to Hajnal on 29 December 1955 that since understanding of demographic phenomena 'could result only from the study of the past, I believe, as you do, that one should spend more time on that study than on computing complicated projections or forecasts. Yet I am not sure that these long and apparently unprofitable studies are always well regarded; the quest for profitability remains very strong and I fear that the desire for immediate apparent usefulness may often cause people to prefer a deluge of supposedly precise calculations to a slow elaboration of methods capable of improving actual effectiveness—but only later' (Rosental, 2003, pp. 103–4). These conclusions were later endorsed by Paul Demeny (2004) in his commentary on the courageous production of population projections for the next three centuries by the UN. However, while this measured approach has been endorsed by such perceptive analysts, the recent UN projections have been based on Bayesian statistical methods using more specialised and complex methods than hitherto (Raftery *et al.*, 2012).

Demographic methods

The relationship between period and cohort indicators of demographic variables has become a topic of particular importance in recent decades with very low levels of period fertility experienced in many countries, and TFR values of below 1.3 children per woman common in the 1990s (Billari and Kohler, 2004). If 100 women have only about 60 surviving daughters on average, then in the long term and in the absence of in-migration the population would fall by about 40 per cent each generation. Period measures such as TFR have been historically volatile and they might not be the best indicator of long-term patterns. John Hajnal was the first demographer to investigate this issue in detail, introducing ideas of postponement and anticipation of fertility which can affect such period indices. In his 1947 *Population Studies* article he analysed the sharp fluctuations in period rates that had occurred in developed countries in the 1930s and early 1940s drawing especially on the patterns in Germany in the 1930s. Couples had the ability to alter the timing of their births and so 'a change in the rate at which people are having children in a given year [could] no longer be taken as an indication of a change in the number of children they [would] bear altogether in the course of their reproductive lives'

(Hajnal, 1947, p. 143). He concluded that ‘demographic analysis in future must study changes in the number of children born over the whole of their married lives to successive cohorts of marriages and relate yearly fertility rates to the number already born to the marriages in question’ (Hajnal, 1947, p. 153)—he noted that this would also hold for birth cohorts, but that availability of data in practice restricted analysis to married couples. He was clear that the issue was conceptual rather than one that more sophisticated measures could address: ‘It is, however, clear that no more complicated calculation will take the place of the net reproduction rate, which, according to the view now common, is the index of the prospects of population growth. For, if the argument of this paper is sound, it follows that the question “To what extent is the population replacing itself according to the rates of this year?” is a futile question’ (Hajnal, 1947, p. 162). With regret, it must be noted that ‘replacement rates’ based in period measures are still widely cited by both national and international statistical agencies.

This is not to say that the Royal Commission work of John Hajnal and colleagues was greeted with universal acclaim. In a discussion meeting of the Institute of Actuaries in 1950, Bernard Benjamin, later professor of Actuarial Studies at City University, London, opened his remarks by stating that ‘it was easy to criticize destructively a report based upon so many shades of opinion, a report whose compilers had been handicapped by having to draw less upon fact than upon speculation’ (Benjamin *et al.*, 1950, p. 38), but even he was positive about the work of John Hajnal:

For example, temporary postponement of births during an unemployment crisis might not seriously affect ultimate family size but it would upset ‘reproduction rates’. Hajnal (*Population Studies*, 1947, 1, 150) quoted the experience of Germany after the Nazis came to power ‘that the rates of those (marriages contracted before the dictatorship) who had postponed births to make up rose more than the fertility rates of those who had not’ showing that ‘family size changes fairly slowly’. Hajnal, dealing in the same article with the stability of family size, put an important point.

To establish that changes in fertility rates are not necessarily an indication of changes in family size it is not necessary to have any very extravagant idea as to the extent to which the number of children is planned and foreseen. It is not necessary to assume that all married couples begin their married life with a fixed idea (afterwards invariable) as to the number of children they want, that they are all completely successful in having this number of children, no less and no more, and in ‘postponing’ and ‘anticipating’ childbearing exactly when they wish. (Benjamin *et al.*, 1950, pp. 41–2)

The 1947 paper introduced a range of ideas that form the basis for much later work, including the relationship of period and cohort meas-

ures, the need for standardisation for previous marriage and childbearing (by use of marital status and parity-specific indices), the distinction between fixed and moving targets, and the complications that would be likely to arise as couples gained more control over their fertility which would need new approaches moving beyond the 'natural fertility' model where couples were assumed not to alter their behaviour in the light of previous fertility experience. This work has been taken forward by perceptive scholars such as Ryder (1964), Bongaarts and Feeney (2008) and Ní Bhrolcháin (1992).

Standardisation

In addition to his work on projections, John Hajnal was particularly concerned with formal modelling of fertility and, in particular, marriage processes. He did work concerned with the two-sex problem (Hajnal, 1948). Models involving one group are relatively straightforward but once the cooperating and competing interests of two or more groups have to be taken into account, the technical problems become formidable and in some cases intractable without specific and sometimes arbitrary assumptions. However, the practical application of such models has been limited, in part because the detailed data required for both men and women were rarely available.

On the other hand, he developed a new simple measure of nuptiality that is still widely used in demography. He formulated the key idea of a singulate mean age at marriage (SMAM: Hajnal, 1953*a*). The idea behind this was straightforward in retrospect. The average number of years spent before marriage (i.e. in the single state) by a group of people who eventually marry is simply equal to the mean age at first marriage of that group. In practice calculations are usually based on women between the ages where the great majority of first marriages take place, typically 15 to 50. Therefore it is possible to derive estimates of the mean age at marriage in societies where there may be information about the cross-sectional marriage status of the population by age from diverse sources such as censuses or tax rolls, even if no explicit information is collected about age at marriage itself (although some assumptions are required). As with much of his other work, John Hajnal used data from a range of countries to show how the indicator can elucidate marriage patterns in his article on the marriage boom in *Population Index* (Hajnal, 1953*b*). In this paper he shows that crude marriage rates and proportions single are inadequate for making useful cross-national comparisons, and SMAMs were used

extensively in discussing the results. SMAM remains a key global demographic indicator: the *World Fertility Report 2009* contains data on the singulate mean age at marriage for 190 countries or areas with the total population of 100,000 or more inhabitants in 2009 for three reference dates where available (United Nations, 2011). It has also been widely used with historic census data to elucidate research questions, for example by Woods and Hinde (1985) and Wrigley (1994).

The series of Royal Commission reports and associated academic papers were landmarks in both the development of new methods and in setting out clearly the context and options for future population growth. However, John Hajnal followed his own advice in his 1955 *JASA* paper and looked for insight from the past, where he was to achieve his greatest prominence.

Historical Demography

John Hajnal's most influential work was the chapter 'European marriage patterns in perspective' in the 1965 volume *Population in History* (Hajnal, 1965). He identified a clear discontinuity in marriage patterns in Europe in the period before 1900 (the latest date included) between those living on either side of an imaginary line connecting St Petersburg (Leningrad at the time of publication) and Trieste. With his innate modesty John Hajnal would be unlikely to characterise it as such, but it is now generally referred to as the 'Hajnal line'. It remains a key organising concept in social and demographic history as evidenced by a recent book *Marriage and the Family in Eurasia: Perspectives on the Hajnal Hypothesis* (Engelen and Wolf, 2005) and a special edition of the *Journal of Comparative Family Studies* (Brădăţan, 2012).

John Hajnal was familiar with living arrangements in much of Europe, especially Central Eastern Europe, given his Hungarian background. There had been earlier work on family forms in historic Europe, especially the work of Frédéric Le Play (1855). This had led to discussion about the so-called stem family system in Europe and the extent to which it varied across the Continent. However, detailed analysis of European patterns was lacking and it was not until 1965 that John Hajnal produced the seminal paper bringing together information on the distribution of marriage patterns across the Continent drawing on a wide variety of statistical and non-statistical sources. He argued that there was a clear distinction between Eastern and Western Europe (although he uses the term

'European' to refer to what is now usually called the Western or sometimes Northwest European marriage pattern). The Western marriage pattern was characterised by relatively late age at marriage, an average age of first marriage for women about 23 and 26 for men with spouses relatively close in age; high fractions, 10–20 per cent, remained unmarried; and marriage involved the establishment of an independent household by the young married couple. Eastern Europe was characterised by higher proportions marrying and at earlier ages, with large residential groups, typically involving multiple generations, and higher fertility being offset by higher mortality. Although non-European evidence was sparse, Hajnal reviewed the available studies on marriage patterns in other societies and concluded that the West European marriage system appeared to be unique. As a result, only about half of all women aged 15 to 50 years of age were currently married in the West compared with about 70 per cent in the East.

The Western European pattern of late and non-universal marriage was crucial for population growth since it restricted fertility, given that the great majority of births in most countries occurred in wedlock (although very shortly after in many cases). Late marriage therefore had a very substantial impact on overall fertility levels.

Subsequent research has identified some exceptions to this simple pattern and shown that variations exist within each area, but the central conclusion that there are substantially different patterns in these two broadly distinct regions in Europe is not challenged. The relevance of the findings and research agenda remain undiminished in the light of subsequent research (for example, van Zanden and de Moor, 2010). Consequently, the debate moved on to the interpretation of these findings. While the data presented referred mainly to the sixteenth to late nineteenth centuries, the question of provenance remained unclear. Was the pattern of long standing or one that had arisen more recently? Was the pattern common to all groups in society, or did it vary by social status? Were gender relations substantially different in Western and Eastern Europe? A second set of questions related to the wider implications of these findings. Was it coincidence that early industrialisation occurred in these Northwestern European countries, or did their apparently unique marriage patterns play a role? These issues were identified as topics for further research in the paper and they have been vigorously debated since.

While not the only source of information on historical social structure, this work provides a framework both for more localised studies and for debating wider socio-economic trends. John Hajnal's work on the

European Marriage Pattern was influential with social scientists in other disciplines such as Jack Goody and Alan MacFarlane (Goody, 1983; MacFarlane, 1976). In a sequel article, 'Two kinds of preindustrial household formation system',¹ in *Population and Development Review (PDR)*: Hajnal, 1982), he narrowed the Western component to Scandinavia, Britain, Iceland and parts of France and Germany where the data were both more complete and more consistent with the formal rules for household formation he set out, but the disciplinary perspective broadened. His interest in the life-cycle of servants and its link with marriage age was especially important from a social structural as well as demographic perspective. He also broadened the comparator areas to include India and China, in particular using 1951 Indian Census data extensively. While the 1965 paper had considered household formation, marriage has been the main focus, although in those periods they were intimately related of course. The 1965 paper had concentrated mainly on presentation of findings, but it was underpinned by a Malthusian framework, whereby the gatekeeper to marriage was the ability of the young couple to establish an independent livelihood which might require, for example, inheritance or gaining control of a family farm. However, marriage was not the only factor involved in household formation and he set out two kinds of household formation systems that differed along three main axes with stylised rules of normal household formation behaviour. These were referred to as the Northwest European simple household and joint household systems respectively. Their characteristics were as follows:

Northwest European simple household system	Joint household systems
Late marriage for both sexes	Earlier marriage for men and rather early marriage for women
After marriage a couple are in charge of their household (the husband is head of household).	A young married couple often start life together in a household of which an older couple or a formerly married older person continues to be head. Usually the young wife joins her husband in the household of which he is a member.
Before marriage young people often circulate between households as servants.	Households with several married couples may split to form two or more households, each containing one or more couples.

Source: based on Hajnal (1982), p. 452.

¹ This paper is often cited under the title 'Household formation patterns in historical perspective'.

He showed that these rules could explain the main differences in household size and structure between these major regions, while also emphasizing that Northwest Europe was distinct not only from Eastern Europe but also other parts of the world for which information was available.

Only one area, his 1965 tentative conclusion that the Western European marriage pattern emerged relatively late, possibly around the sixteenth century, has been seriously challenged (Smith, 1983), although even here in his 1982 article he had already downplayed this earlier suggestion. He argued there that these rules were unlikely to have emerged in the sixteenth century and that fragmentary evidence suggested that the rules were in operation for many centuries earlier.

Statistical Methods

His 1960 paper in the *Journal of the Royal Statistical Society (JRSS)* on the probability of incestuous marriages owing to artificial insemination (i.e. a couple could unknowingly have a common father who was an artificial insemination donor) marked a shift in emphasis from the core demographic topics John Hajnal had been concerned with previously (Hajnal, 1960). The paper was a probabilistic analysis using approaches from statistical genetics. This shift was also evident in his later paper in *Proceedings of the Royal Society B* (Hajnal *et al.*, 1963) which extended earlier work on consanguinity to the case of overlapping generations by making random mating between a man and a woman depend on the interval between their dates of birth. A theoretical model is developed which is compared with observed values. The paper was one in a volume based on a discussion meeting at the Royal Society concerned with the interface of demography and biology, and included contributions from the major scholars in demography at the time, including Louis Henry, David Glass, Ronald Freedman, Bill Brass and Frank Notestein. By this time, Hajnal was also well regarded as a mainstream probabilist since he had been invited to join the editorial board of the *Journal of Applied Probability* in 1964. His work in later years was concerned in particular with inhomogeneous Markov chains, where he made a number of substantial contributions summarised in Seneta (2013). He published relatively little of a purely mathematical nature: only about eight papers in total, almost all as sole author.

Public Policy

John Hajnal did not play a substantial part in public affairs, but he was particularly concerned with education. He obtained a fellowship from the Nuffield Foundation in 1968 to write a book on reforms of the sixth form and university undergraduate curricula. He believed passionately that the UK's 'A-level' system which restricted the long-term choice of students from around age 14 to a narrow set of options was wrong and that they should have a broader education and only specialise later. It may be that he was conscious that he would have preferred to take a subject like mathematics at university rather than classics. In the event, he was able to draw on his extensive knowledge on the organisation of schools and universities in a number of countries. He argued that the English system in contrast to those in Scotland, USA and Continental Europe led to students who fail to have both literate and numeric skills. The result was a short book *The Student Trap*, published by Penguin (Hajnal, 1971).

Postscript

John Hajnal was fortunate to enter demography at a time when new methods such as those for population projection were only recently developed and there was considerable scope for imaginative use in applications. He was possibly less fortunate in that much of his work was based on a topic of high importance and interest at the time, namely that of marriage. Marriage is not only important in itself as a demographic variable, but the strong association between fertility and marriage meant that it was the key variable for attempting to understand changing patterns of fertility. The great majority of childbearing in England had taken place within marriage and marriage was frequently followed very shortly by birth so marriage retained a direct role in determining population change. Most of the contemporary information that was used for analysis was derived from vital registration data and censuses, which only collected information about married women's experience. Indeed little demographic information had been collected since the 1911 Census of England and Wales and even basic information such as age of mother had only started to be collected in vital registration since 1938. Therefore scholars of this time had to use these published data, but within two decades much more information started to become available from other sources, particularly

social surveys for contemporary populations and record linkage studies of historical populations. The focus of analysis tended to move towards statistical modelling of survey data rather than the analysis of census and vital registration tabulations. The focus of policy and substantive interest, unsurprisingly, turned toward the measurement and implications of rapid population growth in Third World countries.

John Hajnal's demographic work largely concentrated on marriage. He was to make major contributions to elucidating the role of marriage for historical populations, especially in cross-national context. Work by Hajnal and others emphasised the key role of marriage as a gatekeeper of fertility in the past. The ability to marry was a major restriction on population growth. Late marriage age and high fractions never marrying reduced the number of births a woman expected to have over her lifetime.

However, for a number of reasons the role of marriage became less prominent in contemporary demographic research. Economic restrictions became much less relevant as couples were able to marry when they felt appropriate rather than being subject to external constraints such as having to wait to inherit a family landholding. Childbearing outside marriage became much more common, now accounting for close to 50 per cent of births in England and Wales. While John Hajnal had produced a number of important studies on contemporary marriage published in major journals such as the *American Sociological Review* (Hajnal, 1954a, 1954b), these have attracted relatively little attention in the last half-century or so, reflecting the changing emphasis in the discipline. In contrast, his 1965 paper on the Hajnal line has been cited 1,741 times (Google scholar as at August 2013); it has been suggested that this is possibly the most highly cited publication in historical demography. His second most cited paper is the 1982 *Population and Development Review* paper, which has over 600 citations.

John Hajnal was not a person who was inclined to push himself into prominence. He did not establish a research group, nor was he highly visible in international statistical or demographic conventions. Some of his best work was contained in the publications of the Royal Commission on Population and thus failed to receive the attention that might have been expected in more mainstream academic outlets. For example, postponement of fertility was later to form a topic of strong interest in the context of the major declines of fertility in countries in the later part of the twentieth century. The roots of technical analyses in this area are usually traced back to influential work by Bongaarts and Feeney (1998). Hajnal's early work was closely related to cohort rather than period approaches to the analysis of fertility, but in this area most work is traced back to the

important work of Norman Ryder (1964). It is perhaps not surprising that Hajnal's work on postponement failed to become a major topic of interest in the middle of the twentieth century. At that time, childbearing was getting younger rather than older and so concerns with the implications of changes in timing of births, if any, centred not on postponement but rather the reverse. John Hajnal himself did not follow up much of his early work for the Royal Commission and therefore this work, referred to as 'superb' by Hobcraft (1996, p. 486), tends to be overlooked. There is only a single citation in the major book covering technical demography—*Applied Mathematical Demography* (Keyfitz and Caswell, 2005)—and that to his 1955 paper in the *Journal of the American Statistical Association* on population forecasting. A similar comment can be made about his work on population projections. He was the foremost expert in the area in Britain in the late 1940s, and he wrote the influential and insightful 1955 *JASA* essay reflecting on his experiences. He was capable of lively writing; his comment in that paper that population projections would benefit from a little more cogitation and a little less computation is one that is now widely acknowledged. However, this also was his swan song in this particular area and his interests moved on elsewhere as noted above.

The reputation of his work on historical demography rests substantially on only two papers, one published in 1965 and the other in 1982. In the intervening period, he produced little work in this area even though it had become a major focus of interest. In 1972, a substantial work edited by Peter Laslett with Richard Wall (1972), *Household and Family in Past Time*, included studies from eminent scholars. Many of these had been stimulated by the work of Hajnal, and included in-depth studies on household structures on both sides of the Hajnal line. John Hajnal himself did not appear in the volume, even though attempts were made to encourage him to contribute to such volumes. The reason why he was not involved remains unclear.

John Hajnal was able to make substantial contributions to a number of distinct academic fields. His output was not large but has been enormously influential. The Hajnal line work created interest across a range of disciplines and in a number of areas: after more than half a century it is still widely used as a framework for discussing household structure and change within Europe. Questions that arose included the extent to which the pattern that he identified mainly for the sixteenth to early twentieth centuries, had been a long-standing pattern or had arisen due to social and economic changes such as feudalism. It also provided a potential framework for explaining the diverging development patterns in Eastern

and Western Europe. It raised the question of how far the Western (or Northwestern) European marriage pattern was a factor in the emergence of industrial development in that part of the globe.

John Hajnal had a keen interest in ideas but he was not as visible in administrative and scientific organisations as might have been expected for someone of his standing. He did not organise scientific meetings or edit books. He ‘went his own way’, as his gravestone says. However, he was unfailingly courteous and his work continues to have a major influence on historical demography. He died on 30 November 2008.

MICHAEL MURPHY

Fellow of the Academy

Note. As the author had only limited interaction with John Hajnal, this memoir relies heavily on contributions from Chris Langford, Richard Smith, Eugene Seneta, Tony Wrigley and members of the Statistics Department at LSE, whose help is gratefully acknowledged. See also the obituaries by Eugene Seneta in the *ISI Newsletter* (Seneta, 2010) and one in the *Jewish Chronicle* of 5 February 2009 <<http://www.thejc.com/social/obituaries/obituary-john-hajnal>>.

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