BIOGRAPHY OF LEON N. MOSES

by

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MOSES, Leon Nathan (1924 - 2013)

Moses was born in New York City on 27 October 1924. He was educated at The Ohio State University (BA, 1945) and Harvard University (MA, 1950, Ph.D. 1952).

From 1952-59 he was a research associate at the Harvard Economic Research Project. In 1957 he became an assistant professor in Harvard's Department of Economics. In 1959 he moved to Northwestern University, where he remained for the next 46 years until his retirement in 2005. In Northwestern's Department of Economics he was initially an associate professor, became a tenured professor in 1963, and served as chair of the department from 1970-72. Throughout his career at Northwestern he held a joint appointment in the university's interdisciplinary Transportation Center, where he served as director of research from 1960-64, and director from 1974-79. He died on October 12, 2013 in Evanston, Illinois.

Moses' work is primarily concerned with the economics of firm location, and the critical role played by transport and transport costs. His exploration of these issues started with his doctoral work under the supervision of Wassily Leontief on input-output models. His thesis, published as a journal article in 1955, was the first application of input-output analysis to study interregional trading relationships. In this paper the United States was divided into three regions, and a model was estimated on the trade within and between these regions for eleven industries. His involvement in input-output analysis continued in postdoctoral work in Leontief's Harvard Economic Research Project.

During the 1950s he proposed a number of fundamental refinements of input-output theory. The first refinement was aimed at remedying the hitherto simplistic treatment of individual firms' production decisions. Previously, inputs such as raw materials and labour were assumed to be combined in fixed proportions and at fixed prices. In a 1958 paper, Moses argued that the model should be modified to make it consistent with the theory of the firm, in that the chosen combination of inputs depends on their relative prices. Moses' innovation was to argue that these prices would vary from location to location due to transport costs. For example, the price of iron ore to a steel mill will depend on how far the mill is from the place at which the ore in mined, and the type of transport available between the mine and the mill.

The second refinement concerned optimization. Previously, input-output models were static representations of observed industry locations and trade flows. The models could be used to conduct comparative-static analyses to estimate the effect of changes in specific parameters, such as an increase in demand in one region, but were not amenable to being used to determine a general equilibrium or an optimum. In a 1960 paper, Moses proposed that linear programming methods could be used to solve the model, subject to the constraint that the labour costs involved in both production and transport were minimized. Consistent with his 1958 paper, factor prices varied by location. In a new departure for input-output analysis, the cost of transporting goods between regions was explicitly modelled. The 1960 paper presented both the theory and an empirical application to the nine United States census regions for sixteen different industries.

Whilst factor prices varied by location in the 1960 paper, they were not endogenously determined in the optimization. The inability to restructure input-output models to be consistent with the theory of the firm promoted Moses to denounce their use in his 1973 presidential address (published 1974) to the Regional Science Association. He argued that the models had "difficulties that limit their usefulness and make it difficult to interpret results". The difficulties were that the relative quantities of inputs did not vary with factor prices changes, the supply of factors of production was perfectly elastic even in the short run, and final demand was totally inelastic with respect to prices. Nowadays, outside of some centrally-planned economies, there is little academic or practical interest in using input-output models.

Moses continued his investigations of firm location and production decisions using models other than input-output analysis. A 1976 paper with John Ledyard considered location decisions in time as well as in geography. The paper considered the optimal time to harvest trees, and how it varies depending on how far the stand of trees is from the sawmill. Papers in 1982 and 1985 with Lanny Arvan considered optimal production decisions by firms who have to trade off the economies of scale from producing a large amount of a product at one time versus the inventory cost of holding the product until consumers purchase it. The 1985 paper combined production choices over time with the allocation of production between a firm's geographically-dispersed plants. In this model, the ultimate price paid by a consumer depends on the distance the product has been transported from the plant that manufactured it.

Moses also applied his models of firm location to examine the evolution of the structure of urban areas. He did so at a time when there was considerable public policy debate concerning the exodus of population and workplaces from the traditional central cities to the suburbs. A 1973 paper with Raymond Fales concluded that the high cost of local freight transport by horse-drawn wagons in the nineteenth century led industrial firms to locate in the downtown core of Chicago next to railroad terminals and river wharfs. These economics forces were so strong that firms rebuilt their premises in the same locations after the Great Fire of 1871 destroyed downtown Chicago. The substitution of motor trucks for horse-drawn wagons in Chicago in the period around the First World War was studied in a 1967 paper with Harold Williamson, Jr. Because local freight transport became cheaper and faster, it was possible for industrial plants to relocate to city neighborhoods where land was cheaper. The paper also observed that the development of the Interstate Highway System caused a similar dispersion of manufacturing plants to the suburbs in the 1950s. Because of these trends, a 1978 paper with Alex Anas predicted that older urban areas in the United States would be

transformed from having a strong central core toward a "multinucleation" structure with multiple centers of economic activity arrayed around a metropolitan area.

The cost of transport is not just the fare or tariff that users have to pay to a carrier. Shippers of freight have to bear the inventory carrying costs whilst their goods are in transit, and passengers' value the time that they have to devote to travelling. In a series of papers in the 1960s and 1970s, Moses looked at the demand and cost conditions for various forms, or modes, of transport, and how users would choose between competing modes.

The first investigation concerned choices by urban commuters. In the early 1960s there was considerable professional interest in the development of large scale models of urban transport demand. In the mode choice segment of these models, travellers trade off the cost and speed of various modes. Therefore, empirical estimates of the monetary value of travel time are crucial to the modelling. Moses approached the estimation by using the traditional labor economics model where workers can trade off the money from working extra hours against their valuation of lost "leisure" time. In a widely-cited 1962 theoretical paper, Moses analyzed the distortions to this model when workers cannot make this trade off because they have to work a set number of hours per week. Of course, one component of "leisure" time is the time that is necessary to commute to and from work. The model in the 1962 paper was extended in a 1963 paper with Williamson to explicitly consider commute time. This new model provided a theoretical basis for valuing travel time. An extensive literature subsequently developed, especially in Great Britain, on the estimation of transport users' value of time.

The 1963 paper also had an empirical component which cast doubt on the effectiveness of a then newly enacted public policy decision to subsidise public transport fares to reduce congestion on the highways. The paper concluded that only thirteen per cent of the automobile commuters in Chicago who could switch to the public transport system would actually choose to do so, even if the fare was reduced to zero. This paper, along with a large mode choice literature that appeared in the 1960s and 1970s, assumed that travellers make discrete choices. A specific traveller that elects to take the bus is always assumed to make this choice unless the parameters of the model changed. This is not true in reality, as some travellers may take the bus for most of their commuting trips, but may take a taxi on occasions. A 1984 paper with Alex Anas presented the theoretical econometrics of an alternative travel demand model that allowed the blending of modal choices, and illustrated the model using data from commuting trips in Seoul, South Korea.

The second investigation concerned freight transport. From 1965-70 Moses directed a large study funded by the United States Army Corp of Engineers on the economics of the inland waterway system (Moses and Lave, 1970). The study funded five doctoral dissertations on the competitive relationship between waterway transport and the railways, the cost structure of the two modes, and pricing of the waterways. A 1968 paper with Michel Beuthe analysed the mode choice of grain shippers and how this varied depending on differences in average transit time and other factors such as delays, unreliability, and accidental damage.

At the time of the inland waterways study, freight (and passenger) transport in the United States was heavily regulated. In the 1970s there were proposals for regulatory reform. Moses organized a series

of conferences in the late 1970s to examine the prospects for deregulation. Conferences were held on aviation (1975 and 1979), the trucking industry (1977), and ocean transport (1978). Deregulation of the airline and trucking industries occurred in 1978, and railway regulation was liberalised two years later. By the mid-1980s there was a growing public concern that the economic freedoms granted to airlines and trucking firms had led to a decline in safety. A 1987 conference and a subsequent book (Moses and Savage, 1989) brought together academics and practitioners to examine the various aspects of the issue, and concluded that there was limited empirical evidence to support the contention. However, the trucking industry was subject to additional safety regulations in the early 1980s, and enhanced enforcement of these regulations.

Subsequent to this conference there was a series of papers in the late 1980s and early 1990s with Ian Savage that dealt with safety in the aviation and trucking industries. The work on trucking culminated in a 1997 paper that conducted a cost-benefit analysis of federal government programs that were enacted after deregulation to increase the resources devoted to enforce minimum safety standards.

The final conference that Moses organized provided a link back to the very start of his career. In the late 1980s there was considerable concern that public safety and the environment were endangered by the transport of hazardous materials and hazardous wastes. A 1990 conference and a subsequent 1993 book (co-edited with Dan Lindstrom) looked at the legal, political, economic and engineering aspects of the problem. Consistent with his earliest work, firms may choose to locate so as to minimize their exposure to the liability of transporting hazardous inputs, products or by-products.

In addition to his research, Moses was an award-winning teacher and was particularly noted for his rigorous teaching of undergraduate intermediate microeconomics, and encouraging undergraduates to undertake research projects as part of their economics training.

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