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Econometrics and the Cost of Capital

edited by Lawrence J. Lau

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Econometrics and the Cost of Capital: Essays in Honor of Dale W. Jorgenson

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Preface

Lawrence J. Lau

1. Introduction

Dale W. Jorgenson introduced the concept of the cost of capital in his celebrated article, "Capital Theory and Investment Behavior" (1963; reprinted in Jorgenson, 1996a). This volume provides a comprehensive overview of the applications of the cost of capital in the many diverse areas in economics. In chapter 1 we review the historical origins of the concept of capital as a factor of production with a rental price given by the cost of capital. (It is important to note that the "cost of capital" is used in a different sense in the literature on financial economics. For example, Modigliani and Miller (1958) use this term to denote the weighted average rate of return to equity and debt, one component of the rental price of capital services.)

The unifying theme of Jorgenson's many contributions to economics is a model of the cost of capital and investment. This consists of a forward-looking model of future asset prices and a backward-looking model of past accumulations of capital. At each point of time these models are linked through the quantity of investment and the rental price of capital services or the cost of capital. In chapter 1 we consider the role of the cost of capital in modeling investment behavior, technology and productivity measurement, consumer behavior and welfare measurement, and intertemporal general equilibrium modeling. We review Jorgenson's contributions to each of these areas chronologically. Finally, we outline the research opportunities still remaining.

2. Investment Demand, Capital Income Taxation, and the Cost of Capital

Jorgenson (1963) introduced all the important features of the econometric models of investment behavior summarized in his survey paper, "Econometric Studies of Investment Behavior: A Review" (1971; reprinted in Jorgenson, 1996a). Prior to Jorgenson's work the modeling of investment behavior had been based on various *ad hoc* principles, such as the capacity principle, the profits principle, and the like. His work initiated the cumulative progress in modeling of investment that has continued up to the present.

Jorgenson's key innovations are the derivation of investment demand from a model of capital as a factor of production, the incorporation of the tax treatment of income from capital into the rental price of capital services, and new econometric methods for modeling gestation lags in the investment process. Recent research surveyed by Ricardo Caballero (1999, p. 821) has confirmed the continuing empirical validity of the long-run relationship between investment and the cost of capital. Current research concentrates on capturing the features of more detailed data sets now available, especially the short-run dynamics of investment behavior at the firm and establishment level.

The relationship between investment and the cost of capital remains an important focus of the empirical literature on the dynamics of investment demand. Similarly, the theory of investment proposed by Jorgenson (1967) has retained a central role. The econometric methodology for modeling gestation lags based on rational distributed lags, introduced by Jorgenson (1966; reprinted in Jorgenson, 1996a), has been assimilated into the statistical literature through the "transfer function" approach of Box and Jenkins (1970).

Jorgenson (1963) originated the cost-of-capital approach to the taxation of income from capital. This approach makes complex tax provisions for capital income much more transparent. The special strength of the cost-of-capital approach lies in its ability to absorb almost unlimited detail on the features of specific tax policies. This approach has had important practical consequences by providing a precise instrument for achieving horizontal equity in capital income taxation.

The principle of horizontal equity holds that taxpayers in the same circumstances should have the same tax liabilities. The appeal of this principle is threefold. First, it achieves fairness in the sense of equitable treatment of citizens before the law. Second, under the rubric

of "tax neutrality," it eliminates any possibilities for increasing economic efficiency by redistributing the tax burden. Finally, it leads to simplicity by expunging from tax statutes the detailed specifications of transactions subject to special provisions.

The principle of horizontal equity for capital income taxation was embodied in the Tax Reform Act of 1986 in the United States. This legislation reversed decades of piecemeal creation of specific incentives for particular classes of taxpayers. Similar reforms have now been adopted in industrialized countries around the world, broadening the base for capital income taxes and reducing tax rates. These reforms have contributed greatly to more efficient allocation of capital within market economies.

The article by Robert Hall and Jorgenson, "Tax Policy and Investment Behavior" (1967; reprinted in Jorgenson, 1996b) makes the concept of the cost of capital more exact and employs this concept in the analysis of alternative tax policies. Jorgenson's cost of capital had been incorporated into all major forecasting models in the United States by the early 1980s. And simulations of the short-run economic impacts of alternative tax policies had become the staple fare of debates over specific tax proposals. Simulations of the long-run impacts of tax policy based on the cost of capital, surveyed by Yolanda K. Henderson (1991), made their appearance in tax policy debates by the end of the 1980s.

Alan Auerbach and Jorgenson augment the cost of capital framework by introducing the marginal effective tax rate in their article, "Inflation-Proof Depreciation of Assets" (1980; reprinted in Jorgenson, 1996b). Jorgenson's cost of capital summarizes the information about future consequences of investment decisions essential for current decisions about capital allocation. The marginal effective tax rate characterizes the tax consequences of investment decisions in a way that is particularly suitable for comparisons among alternative tax policies. Efficient capital allocation requires equalization of marginal effective tax rates among all assets.

The cost of capital and the marginal effective tax rate were employed in the design of reforms of capital income taxation in the United States and around the world during the 1980s and early 1990s. The reforms are described for nine countries—the G7 plus Australia and Sweden—by Jorgenson (1993) in his "Introduction and Summary" to *Tax Reform and the Cost of Capital* (Jorgenson and Ralph Landau,

1993). Marginal effective tax rates have been compiled for dozens of countries. King and Fullerton (1984), the OECD (1991), The Commission of the European Communities (1992), and Jorgenson (1993) have provided international comparisons.

Hall and Alvin Rabushka (1995) are the originators of the Flat Tax approach to implementation of a national consumption tax. In chapter 2 Hall considers the international consequences of three leading consumption tax proposals—the Flat Tax, the national sales tax, and the personal consumption tax. The analysis of tax reform in the open U.S. economy has to consider the general equilibrium in a world economy with heterogeneous tax systems. Tax systems in major industrialized countries, like the U.S. tax system today, rely on a mixture of consumption and income, including capital income, taxation.

3. Productivity and the Cost of Capital

In the area of productivity analysis and growth accounting, Jorgenson and Zvi Griliches take a crucial step beyond the aggregate production function employed by Robert M. Solow (1957). In "The Explanation of Productivity Change" (1967; reprinted in Jorgenson, 1995a), they allow for the joint production of consumption and investment goods from capital and labor services. This makes it possible to identify the embodiment of new technology with a constant-quality price index for investment goods. Jorgenson and Griliches construct constant-quality indices of capital and labor inputs by weighting the components of each input by their marginal products. The marginal products of the capital inputs are the rental prices of capital services.

Laurits Christensen and Jorgenson (1973; reprinted in Jorgenson, 1995a) extend the model of the cost of capital employed by Jorgenson and Griliches by distinguishing among different legal forms of organizations—corporate business, non-corporate business, and households and institutions. This makes it possible to represent the distinctive features of the taxation of capital income for each of these legal forms of organization. Christensen and Jorgenson imbed the production account employed in productivity measurement in a complete system of U.S. national accounts, including Jorgenson's cost of capital as the price of capital services. This system consists of accounts for production, income (including imputed incomes from consumer durables and owner-occupied residential housing) and expenditure (again

including imputed expenditures on consumer durables and housing), capital formation and wealth.

Jorgenson, Frank Gollop, and Barbara Fraumeni (1987) dispense with the aggregate production function entirely in allocating the sources of U.S. economic growth to the level of individual industries. Their book contains by far the most detailed data ever compiled on investment and productivity in the U.S. economy. Industry outputs are represented as functions of capital, labor, and intermediate inputs, each defined in terms of a constant-quality index of the corresponding inputs. The innovations of Jorgenson, Griliches, Christensen, Gollop, and Fraumeni dramatically reduce the role of (total factor) productivity as a source of economic growth and greatly increase the relative importance of investments in human and non-human capital. These investments respond to changes in economic policies such as tax policies.

In chapter 3 Christensen summarizes his research on capital measurement for the U.S. and other industrialized countries, as well as numerous firms and industries in the U.S. economy. He then focuses on the measurement of productivity and provision of proper incentives for productivity improvement in regulated industries. He observes that regulatory agencies have adopted simplified measures of capital costs based on the nominal cost of capital, rather than the real cost implied by Jorgenson's concept of the cost of capital. This has distorted production and investment decisions in regulated industries, such as the electric power industry in the United States, especially during inflationary periods like the 1970s. Christensen describes a system for incentive regulation, based on the real cost of capital, that would provide appropriate incentives for regulated firms.

In chapter 5 Gollop compares the "production approach" to productivity measurement introduced by Jorgenson (1966b; reprinted in Jorgenson, 1995a) with the "welfare approach," employed by Solow (1957) and others, that preceded it. The welfare approach begins with the income and expenditure account, while the production approach starts from the production account. The production approach captures changes in technology and distinguishes movements along the production possibility frontier from shifts in the frontier, as proposed by Solow. The welfare approach, which is complementary rather than competing, is appropriate for allocating current income between present and future consumption in the form of saving. Gollop shows

how this distinction has led to a resolution of the lengthy controversies that followed the introduction of the production approach.

In chapter 6 Fraumeni considers the features of the Jorgenson system of national accounts. This consists of three major components: the Christensen-Jorgenson (1973) national accounts, the Jorgenson-Gollop-Fraumeni (1987) sectoral production accounts, and the Jorgenson-Fraumeni (1989a; reprinted in Jorgenson, 1995a) human capital and non-market accounts. She points out that the main weakness of the U.S. national accounts is that stocks of reproducible, tangible assets are not linked to the services they produce. This deficiency is overcome by Jorgenson's system. Jorgenson and Fraumeni have extended the system to investment, stocks, and services of human capital and the associated market and non-market activities.

Data on the sources of growth at the industry level similar to those of Jorgenson, Gollop, and Fraumeni (1987) were constructed for Japan by Jorgenson, Masahiro Kuroda, and Mieko Nishimizu (1987; reprinted in Jorgenson, 1995b) and for Germany by Klaus Conrad and Jorgenson (1986; reprinted in Jorgenson 1995b). These data made it possible to compare productivity levels for individual industries in the three countries. The international comparisons required purchasing power parities for capital and labor inputs and outputs at the industry level, extending the purchasing power parities for aggregate outputs developed by Irving Kravis, Alan Heston, and Robert Summers (1982). The purchasing power parity for capital inputs is based on Jorgenson's cost of capital.

Jorgenson and his collaborators show that the U.S. began the postwar period with an enormous productivity advantage over its competitors. Although gains in productivity by Germany and Japan in the early postwar period were very dramatic, the gains slowed markedly after 1973 and these countries emerged as productivity laggards. Defining international competitiveness in terms of the relative prices of goods and services in a common currency, competitiveness has been driven primarily by depreciation of the U.S. dollar since the collapse of the Bretton Woods regime. Relative productivity levels between the U.S. and other industrialized countries have moved in the opposite direction from international competitiveness.

In chapter 7 Charles Hulten and Robert Schwab apply the conceptual framework for international comparisons employed by Jorgenson, Kuroda, and Nishimizu (1987) to regional comparisons within the United States. The key result of the article is that the path

of productivity efficiency has been essentially parallel across U.S. regions in recent decades. This suggests that manufacturing technology and organizational practice had already diffused widely throughout the country by the beginning of the period. This leaves little room for explanations of convergence of regional growth based on technological diffusion, increasing returns to scale, or differential growth of public infrastructure capital.

4. Production and the Cost of Capital

In their article, "Transcendental Logarithmic Production Frontiers," Laurits Christensen, Jorgenson, and Lawrence Lau (1973; reprinted in Jorgenson, 2000) present econometric models of production for the U.S. economy based on transcendental logarithmic price and production possibility frontiers. The innovations embodied in these econometric models—price-quantity duality in production, statistical methods for estimation and inference in systems of nonlinear simultaneous equations, and flexible functional forms—define the standard for econometric modeling of producer behavior. The extensive and growing literature emanating from this approach is surveyed by Jorgenson (1986; reprinted in Jorgenson, 2000).

Price-quantity duality in the theory of production is especially critical in generating econometric models that provide flexible representations of technology. Jorgenson and Lau (1974; reprinted in Jorgenson, 2000) have linked the theory of producer behavior employed in these models to the technological opportunities faced by producers through price-quantity duality. Jean-Jacques Laffont and Jorgenson (1974; reprinted in Jorgenson, 2000) introduce the method of nonlinear three-stage least squares employed in estimating the unknown parameters. Generalizations of this method by Lars Hansen (1982) have become the basis for the Generalized Method of Moments, now the standard approach for estimation and inference in macroeconometric modeling.

In the model presented by Christensen, Jorgenson, and Lau, the economy supplies outputs of investment and consumption goods and demands inputs of capital and labor services. Myopic decision rules for econometric models of production are derived by identifying the rental price of capital input with Jorgenson's cost of capital. An increase in the output of investment goods requires foregoing a part of the output of consumption goods, so that adjusting the rate of investment is costly. However, costs of adjustment are external to the

producing unit and are fully reflected in the market price of investment goods. This price incorporates forward-looking expectations of the prices of future capital services.

An alternative approach to introducing forward-looking expectations in modeling investment was introduced by William Brainard and James Tobin (1968) and Tobin (1969). Tobin's Q is defined as the ratio of expected profits to the market value of the firm's assets. Fumio Hayashi (1982) provided a neo-classical interpretation of Tobin's Q by showing how to identify internal costs of adjustment from the Q-ratio under constant returns to scale in production. Internal costs of adjustment are an alternative to gestation lags in modeling the short-run dynamics of investment behavior. If all costs of adjustment are external and returns to scale are constant, then Tobin's Q is identically equal to unity, as in the model of Christensen, Jorgenson, and Lau.

In chapter 4 Hayashi reviews the theory of investment demand since the publication of Jorgenson (1963). He introduces the corporate income tax and derives Jorgenson's cost of capital. He then presents the Q theory of investment, the Euler equation approach to investment theory, and surveys the complexities that arise from the introduction of multiple capital goods. Finally, he introduces uncertainty and irreversibility of investment and discusses the connections between investment and finance. His theme is the essential role played by Jorgenson's cost of capital in all the existing models of investment. He also points out that the cost of capital is the sole channel through which tax parameters exert incentive effects, which accounts for the central role of this concept in the theory of capital income taxation.

5. Welfare and the Cost of Capital

Christensen, Jorgenson, and Lau (1975, reprinted in Jorgenson, 1997a) present econometric models of consumer demand for the U.S. economy that parallel their models of production. These models are based on transcendental logarithmic direct and indirect utility functions and combine flexibility in the representation of preferences with parsimony in the number of parameters. Jorgenson's cost of capital plays a critical role in modeling consumer demand for housing and consumers' durables. Demands for these commodities are represented in terms of flows of capital services and the prices faced by consumers are rental prices of the capital services. Investments in housing and

consumers' durables are derived from the accumulation equations for the stocks of these types of capital.

The models of Christensen, Jorgenson, and Lau (1975) retain the concept of a representative consumer employed in earlier models of consumer demand. This omits a crucial link between individual and aggregate demands arising from the fact the aggregate demands are sums of individual demands. Lau's (1977, 1982) theory of exact aggregation is the key to surmounting the limitations of the representative consumer model. The essential innovation is to incorporate the attributes of consumers, such as their demographic characteristics that reflect heterogeneity of preferences, into statistics of the joint distribution of attributes and total expenditures over the population.

The econometric model of aggregate consumer behavior presented by Jorgenson, Lau, and Thomas Stoker (1982, reprinted in Jorgenson, 1997a) successfully integrates the two principal streams of empirical research on consumer behavior by pooling aggregate time series data with cross section data for individual households. Moreover, the Jorgenson, Lau and Stoker model permits an exact decomposition of the estimated aggregate demand function into individual demand functions distinguished by demographic and other characteristics. Jorgenson and Stoker (1986; reprinted in Jorgenson, 1997a) have extended the econometric methodology of Jorgenson and Laffont (1974) to permit pooling of time series and cross section data. Stoker (1993) has summarized the extensive empirical literature emanating from the exact aggregation approach to modeling consumer behavior.

In chapter 8 Stoker summarizes Jorgenson's research on consumer behavior. The objective of this research is to analyze economic policy, ultimately, to see how the welfare of individuals is affected by a policy change. The model of aggregate consumer behavior constructed by Jorgenson, Lau, and Stoker (1982) has been used for this purpose in the general equilibrium modeling of Jorgenson, Mun Ho (1994; reprinted in Jorgenson, 1998b), and Peter Wilcoxen (1993; reprinted in Jorgenson, 1998b). This model of consumer behavior embodies important innovations in economic theory and econometric method, as well as econometric modeling that defined the research frontier in this area for nearly a decade. The model successfully captures price, income and demographic effects in a consistent fashion and has provided the foundation for the subsequent developments surveyed by Stoker (1993).

Jorgenson and Daniel Slesnick (1984, reprinted in Jorgenson, 1997b)

introduce an approach to normative economics that exploits the econometric model of Jorgenson, Lau, and Stoker. Measures of welfare for each consumer are recovered from individual demand functions. These are combined into a single indicator of social welfare, reflecting concepts of horizontal and vertical equity. As Amartya Sen (1977) has persuasively argued, this requires dispensing with ordinal measures of welfare that are not comparable among individuals. Jorgenson and Slesnick meet this requirement by constructing cardinal measures of welfare that are fully comparable among individuals.

Jorgenson and Slesnick have constructed measures of the cost and standard of living, inequality in the distribution of individual welfare, and poverty. They have also compared their approach, based on the distribution of total expenditures on consumption, with approaches based on the distribution of income. The distribution of income is used for official measures of poverty, inequality, and the standard of living by statistical agencies in the U.S. and many other countries. Differences between these two approaches are mainly due to differences between the distribution of total expenditure and the distribution of income, but differences in the cost of living and changes in the composition of families are also important. Jorgenson (1990; reprinted in Jorgenson, 1997b) and Slesnick (1998) have surveyed empirical applications of the new approach to normative economics.

In chapter 9 Slesnick summarizes the innovations in applied welfare economics emanating from his research with Jorgenson. The measurement of individual well-being is tied explicitly to an econometric model of consumer behavior to obtain an exact welfare indicator that increases only if utility actually rises. This supersedes index number methods based on consumers' surplus that remain in common use, but provide an exact welfare indicator only for identical, homothetic preferences. The empirical evidence presented by Jorgenson, Lau, and Stoker (1982) and numerous predecessors contradicts these conditions. In addition, the measurement of social welfare is founded on the principles of social choice that have been the exclusive preserve of microeconomic theorists.

Slesnick reviews applications of the econometric approach to applied welfare economics. These include the consequences of changes in economic policy for the distribution of individual welfare, as well as cost of living indexes for individual households, and household equivalence scales. They also include the impact of changes in economic policy on social welfare. The measurement of social welfare

also leads to a new approach to cost of living measurement and new measures of the standard of living, inequality, and poverty. Slesnick compares the results of the econometric approach, based on consumption, with the official income-based measures published in the United States by the Bureau of the Census.

Erwin Diewert (1976) was the first to link the flexible functional forms employed in econometric modeling to index number formulas used in productivity and welfare measurement. In chapter 11 Diewert and Denis Lawrence review the fundamentals of capital theory for productivity and welfare measurement. They point out that Jorgenson's concept of the cost of capital has become the standard for productivity measurement, as in the aggregate and sectoral productivity measures published by the Bureau of Labor Statistics (1983). They consider three alternative models of capital as a factor of production and the cost of capital, based on alternative accounting formulas for depreciation—declining balance, straight line, and one-hoss-shay. Finally, they implement these models for the private business sector in Canada for the period 1962–1996.

6. Economic Growth, Intertemporal General Equilibrium, and the Cost of Capital

Edward Hudson and Jorgenson (1974; reprinted in Jorgenson, 1998a) originate the econometric approach to general equilibrium modeling. Their model of the U.S. economy incorporates econometric representations of technology and preferences as basic building blocks. Earlier approaches to general equilibrium modeling, going back to Leontief (1941), had "calibrated" the behavioral responses of producers and consumers to a single data point. While the calibration approach economizes radically on the use of data, it requires highly restrictive assumptions, such as fixed input-output coefficients. This assumption is contradicted by the massive evidence of energy conservation in response to changes in world energy prices, beginning in 1973.

The concept of an intertemporal price system provides the unifying framework for the econometric general equilibrium model of the impact of tax policy on U.S. economic growth constructed by Jorgenson and Kun-Young Yun (1986a, 1986b; reprinted in Jorgenson, 1996a). The model incorporates the econometric representations of technology and preferences introduced by Christensen, Jorgenson, and Lau (1973, 1975), as well as a forward-looking econometric model of consumer

behavior, based on the "Euler equation" approach originated by Hall (1978). The model includes a rental price of capital services, based on Jorgenson's cost of capital, for each class of assets distinguished in the U.S. tax system.

Both macroeconometric models used to analyze the short-run impact of tax policy and applied general equilibrium models employed to analyze the long-run impact have omitted a forward-looking model of asset pricing. These models are subject to the critique of Robert Lucas (1976) that tax policies change future asset prices, but these changes are not taken into account in models of producer and consumer behavior. Jorgenson and Yun have overcome the Lucas critique by associating each tax policy with an intertemporal equilibrium. Both producers and consumers optimize, subject to an intertemporal price system. In this system asset prices are equal to rational expectations of the present values of future capital services.

In chapter 10 Yun describes the role of Jorgenson's cost of capital in intertemporal general equilibrium modeling of the effects of tax policy. Yun first extends the standard expressions for the cost of capital to incorporate the policy instruments employed in recent tax reform proposals. Second, he summarizes the current version of the Jorgenson-Yun model of U.S. economic growth and applies this to the 1981 and 1986 tax reforms in the U.S. Third, he considers an analytical framework for the welfare analysis of tax policy changes. Finally, he employs this in analyzing the consequences of tax policy reform in the U.S.

Jorgenson and Wilcoxen (1990; reprinted in Jorgenson, 1998b) and Ho and Jorgenson (1994; reprinted in Jorgenson, 1998b) have constructed highly detailed models of U.S. economic growth. These models are based on the detailed accounts for production at the level of individual industries presented by Jorgenson (1990; reprinted in Jorgenson, 1995b), including a price of capital services for each industry and each class of asset, based on Jorgenson's cost of capital. As a basic building block, the models incorporate an econometric representation of technology by industry, constructed by Jorgenson and Fraumeni (1984; reprinted in Jorgenson, 2000). Similarly, the models include the econometric representation of preferences for individual households by Jorgenson, Lau, and Stoker (1982).

In chapter 12 Ho simulates the elimination of tariff and non-tariff barriers to trade in the U.S. These simulations successfully capture the impact of trade policy on Jorgenson's cost of capital and the price of

new capital goods. This gives rise to dynamic effects of trade policy changes through capital formation and economic growth. The magnitude of these effects depends critically on the values assigned to the key parameters. Ho demonstrates the value of the econometric approach to parameter estimation by considering the sensitivity of the results to alternative parameter values like those employed in models calibrated from a single data point.

In chapter 13 Wilcoxen describes a "quiet revolution" in the economic analysis of environmental policy during the 1990s. This is based on the observation that environmental regulation affects Jorgenson's cost of capital and economic growth. Regulations can raise the price of new capital goods, slow the rate of capital formation, and reduce the rate of economic growth. By contrast market-based environmental policies, such as emissions taxes and tradable permits, may raise sufficient revenue to reduce capital income taxes and lower the cost of capital, thereby stimulating growth. The evaluation of an environmental policy requires a model that can capture environmental regulations at a detailed level, trace the effects of these regulations through the economy to determine their impact on the cost of producing new capital goods, and determine the effect on saving and investment.

Wilcoxen analyzes the "double-dividend" hypothesis that market-based instruments for environmental policy have the potential for stimulating economic growth. The weakest form of this hypothesis is true by definition. Using revenue to lower a distorting tax is superior to returning the revenue to consumers through lump sum rebates. The strongest form of the hypothesis identifies possibilities for reducing preexisting distortions, mainly associated with taxes on incomes from labor and capital. This could improve economic welfare even before environmental benefits are considered, generating a double dividend. Wilcoxen employs the distribution of measures of social welfare derived from an econometric general equilibrium model to confirm the hypothesis that shifting to energy taxes in the U.S. would produce a double dividend.

The concept of an intertemporal price system provides the unifying framework for the econometric general equilibrium models of Jorgenson, Ho, Wilcoxen, and Yun. This price system balances demands and supplies for products and factors of production at each point of time. A forward-looking feature of this price system is that asset prices are rational expectations of present values of future capital services, based

on Jorgenson's cost of capital. This is combined with backward linkages among current capital services, the stock of capital, and past investments in modeling the long-run dynamics of economic growth. Jorgenson and Wilcoxen (1993, reprinted in Jorgenson, 1998b) provide a survey of the literature on econometric general equilibrium modeling, including applications to energy, environmental, trade, and tax policies.

7. Acknowledgments

The papers included in this volume were presented at the Conference on the Cost of Capital in Economic Analysis, held in honor of Dale W. Jorgenson's sixtieth birthday at the John F. Kennedy School of Government, Harvard University, on May 7–8, 1993. It was my great privilege to have the responsibility of organizing this surprise conference on behalf of Jorgenson's Ph.D. thesis advisees. The indispensable advice and assistance of Dale's beautiful wife Linda Mabus Jorgenson are most gratefully acknowledged. I wish to take this opportunity, on behalf of his former students, to thank Dale Jorgenson once more for what he has done for us. What successes we may have as economists can be largely attributed to our experience as "apprentices" in his "shop." We could not have found a better teacher and mentor.

After the conference the papers were revised and updated for publication. Erwin Diewert and Denis Lawrence substituted a new paper on capital theory and measurement for the one presented by Diewert at the conference; similarly, Charles Hulten and Robert Schwab substituted a paper on regional growth for the paper presented by Hulten. Ten of the authors are former Ph.D. thesis advisees of Jorgenson—three at Berkeley and seven at Harvard. Two—Diewert and Barbara Fraumeni—were graduate students who benefited from Jorgenson's advice on their dissertations—and Robert Hall was an undergraduate thesis advisee.

The conference was attended by thirty-six of Jorgenson's fifty-six former Ph.D. thesis advisees at Berkeley and Harvard, as of the time of the conference. Three thesis advisees who have subsequently received their Ph.D.'s from Harvard participated in the conference. Many of Jorgenson's current and past research collaborators, professional colleagues, and friends from around the world also attended the conference. Laurits R. and Dianne Cummings Christensen, Robert E. Hall, Charles R. Hulten and Nancy P. Humphrey, Ralph and Claire