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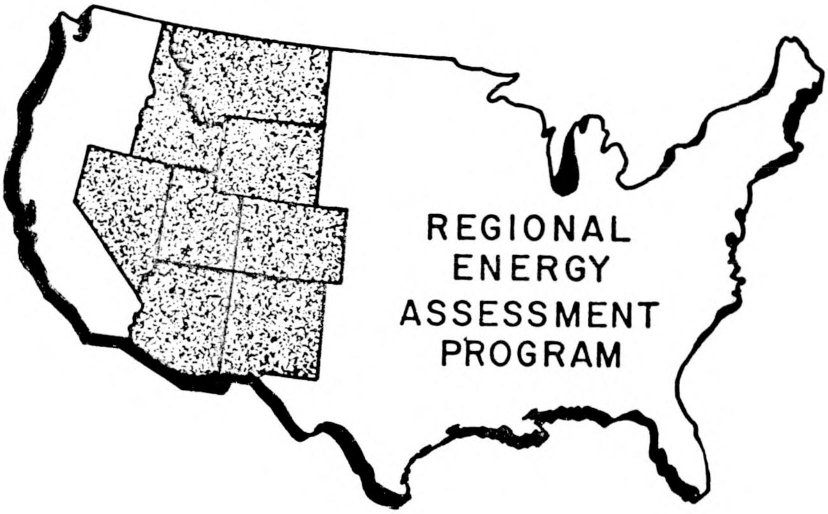

Measuring Social Benefits Attributable to Social Infrastructure in Boomtowns

by

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ABSTRACT

A prerequisite for evaluating alternative investment programs for urban infrastructure is some measure for the benefits attributable to such investments. In boomtowns, benefit measures are of particular importance inasmuch as investment planners may wish to compare the costs of (potentially) excess capacities in the post-boom period with the benefits of higher infrastructure stock levels during the boom. Unfortunately, little is understood concerning a methodology for deriving these benefit measures, and to date investment planning for urban infrastructure has been based simply on cost minimization techniques.

In this dissertation a methodology for developing values which might serve as benefit measures for alternative levels of urban infrastructure is developed and tested. A theoretical argument is proposed which results in a statistically testable proposition concerning tradeoffs between wages and levels of urban infrastructure. In its simplest form, this proposition states that wage differentials between boomtowns and base towns are explained by urban infrastructure differentials. Defining w^* and k^* as wage and infrastructure differentials, respectively, one form for this proposition is $w^* = \beta_0 + \beta_1 k^*$. If the variation of w^* in response to changes in k^* is statistically significant, it is suggested that the coefficient β_1 might then be viewed as a measure of an individual's subjective valuation of urban infrastructure. As such, β_1 might then serve as a measure of infrastructure-related benefits for use by investment planners.

Multiple linear regression techniques are used to test the hypothesis $H_0:\beta_1 = 0$ versus the alternative hypothesis $H_A:\beta_1 \neq 0$. For aggregated

measures of urban infrastructure, w* is found to vary with k* in a statistically significant manner; i.e., H_0 is rejected and H_A is accepted. When efforts were made to disaggregate total infrastructure into functionally differentiable components (e.g., facilities for education, public safety, and water supply), the statistical tests were inconclusive.

Major conclusions of the study are, first, that urban infrastructure appears to have statistically significant impacts on wage differentials. The analyses suggest that wage differentials increase by $.04 (per week) for each dollar by which per capita urban infrastructure decreases. Second, considerable work remains in terms of data development and refinement before one can judge the potential of this method for attributing wage differentials to disaggregated classes of infrastructure.

CHAPTER I

INTRODUCTION

As the United States continues its drive for self-sufficiency in energy, a wide range of problems is beginning to arise in such areas as public safety (e.g., the disposition of uranium tailings), environmental quality, competition for resources with other sectors (particularly, the competition for water with the agricultural sector), and the creation of boomtowns. Current manifestations of these problems are most likely only the tip of the iceberg given the unprecedented scale of new energy developments anticipated in the United States, particularly in the Western States.[1] There is increasing concern as to just how state, federal, and local governments are to deal with these problems to the end of providing some sense of orderliness in this substantial shift in the basic structure of the U.S. energy producing sector.

Of these problems, those associated with boomtowns are the subject of growing concern for policy makers in Rocky Mountain States, reflecting to some extent the recent discouraging experiences witnessed in such communities as Rock Springs and Gillette, Wyoming.[2] The strains placed on oft-times fragile socio-cultural and institutional systems, as well as on urban infrastructure, which result from rapid rates of population

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[1]Federation of Rocky Mountain States, Energy Development in Rocky Mountain Region: Goal and Concern (Denver, March 1974).

[2]John S. Gilmore and Mary K. Duff, The Sweetwater County Boom: A Challenge to Growth Management (University of Denver Research Institute, July 1974).

increases in relatively sparsely populated areas (see Gilmore, 1976) are apparent after only a moment's reflection, and have been described in some detail in several recent works.[1]

To allow for some perspective as to the range of conditions encountered in boomtowns, the following describes conditions found in Sweetwater County, Wyoming, during the 1970-74 period. This is the period associated with the expansion of trona mining and the construction of the Jim Bridger Power Plant (built for the Pacific Power and Light and Idaho Power Companies). Population and employment levels increased from 18,931 to 36,900 and 7,230 to 15,225, respectively (mining employment increased from 1,530 to 2,650; construction employment increased from almost zero to 4,200).[2] The quality of municipal and other local services declined markedly. In the State of Wyoming, the average doctor-population ratio is 1:1100; in Sweetwater County this ratio increased from 1:1800 in 1970 to 1:3700 in 1974.[3] Mental health clinic caseloads increased eight-fold. In 1974, there was an estimated deficit of 128 schoolrooms in the county. Capital costs for providing schoolrooms are estimated to be on the order of $5,100/child; 1970-74 increases in assessed valuation for school districts was but $2,100/child, however.[4] By 1974, the deficit in municipal facilities for homesites (water, sewage, roads, electricity, etc.) was approximately 1,397 home sites (4,599 mobile home

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[1]For example, Gilmore and Duff, op.cit., and J. Gilmore, "Boomtowns May Hinder Energy Resource Development," Science, Vol. 191 (1976).

[2]Ibid., pp. 4 and 6.

[3]Ibid., p. 16.

[4]Ibid., p. 24.

spaces were needed). With little expansion in police facilities, crime rates increased by 60 percent between 1972 and 1973 alone.[1]

The statistics quoted above are only the grossest indicators of the morass of social, institutional and economic conditions that may attend the disruptions brought about by rapid, large scale economic developments in small communities. Increased rates of alcoholism, broken homes, and suicides were among the many manifestations of break-downs in social order in Sweetwater county reported in Gilmore and Duff's seminal work concerning the "anatomy" of a boomtown.

Of course, not all mineral-related developments result in chaotic disorder on a scale like that described above. For example, increased coal mining activity in Cuba, New Mexico, during the 1970-74 period resulted in socio-economic impacts which seem to have been beneficial to all concerned.[2] Although percentage increases in population and employment (156% and 73%, respectively) were not unlike those experienced in Wyoming, the scale of change in absolute terms was relatively small (over the 1970-74 period population increased from 230 to 590). More importantly, perhaps, Cuba seemed to have had substantial excess capacity in terms of municipal facilities prior to the boom (or boomlet).

Further, it is not at all clear that the boomtown phenomena will be limited to the Rocky Mountain region. The much discussed development of

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[1] Ibid., pp. 19 and 21.

[2] Berry Ives and Clyde Eastman, Impact of Mining Development on an Isolated Rural Community: The Case of Cuba, New Mexico (New Mexico Agricultural Experimentation Research Report 301, Las Cruces, August, 1975).

[3] Ibid., Table 2, p. 6.

off-shore petroleum in the George's Bank area might well have similar effects on small communities in the Northeast United States.[1]

While, as suggested above, a wide range of interrelated socio-economic problems may be encountered in the boomtown environment, a particularly perplexing problem for municipal policy makers concerns the issue of framing optimal investment strategies for investments in urban infrastructure. Referring to Figure 1.1, an energy development activity will normally involve a large influx of labor during a construction phase which may last from four to as many as twelve years, after which the labor force, and thus the population, will tend to stabilize at a level related to the labor force required by the operation of the facility.[2] Investment planners are then faced with the following "horns of a dilemma." Capital investments for schools, roads, water supply and waste disposal systems, parks and recreation facilities, etc., at a level which might "adequately"[3] serve the peak population, $\hat{P}$, may result in substantial excess capacities-idle capital-in the post-boom, $\overline{P}$, period. On the other hand, a configuration of urban capital designed to provide "adequate" services for the long-run population level $\overline{P}$ may imply a substantial deterioration in the quality of such services during the oft-times lengthy construction phase. At issue then is just how one might derive such an investment strategy relevant for this decision environment.

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[1]Thomas A. Grigalunas, Offshore Petroleum and New England, Marine Technical Report No. 37 (University of Rhode Island, 1975).

[2]Berry Ives and William Schulze, Boomtown Impacts of Energy Development in the West; Case of Page, Arizona (Lake Powell Research Bulletin, forthcoming, 1976).

[3]A major issue here concerns just what "adequate" might mean. This is discussed in some detail below in Chapter II.

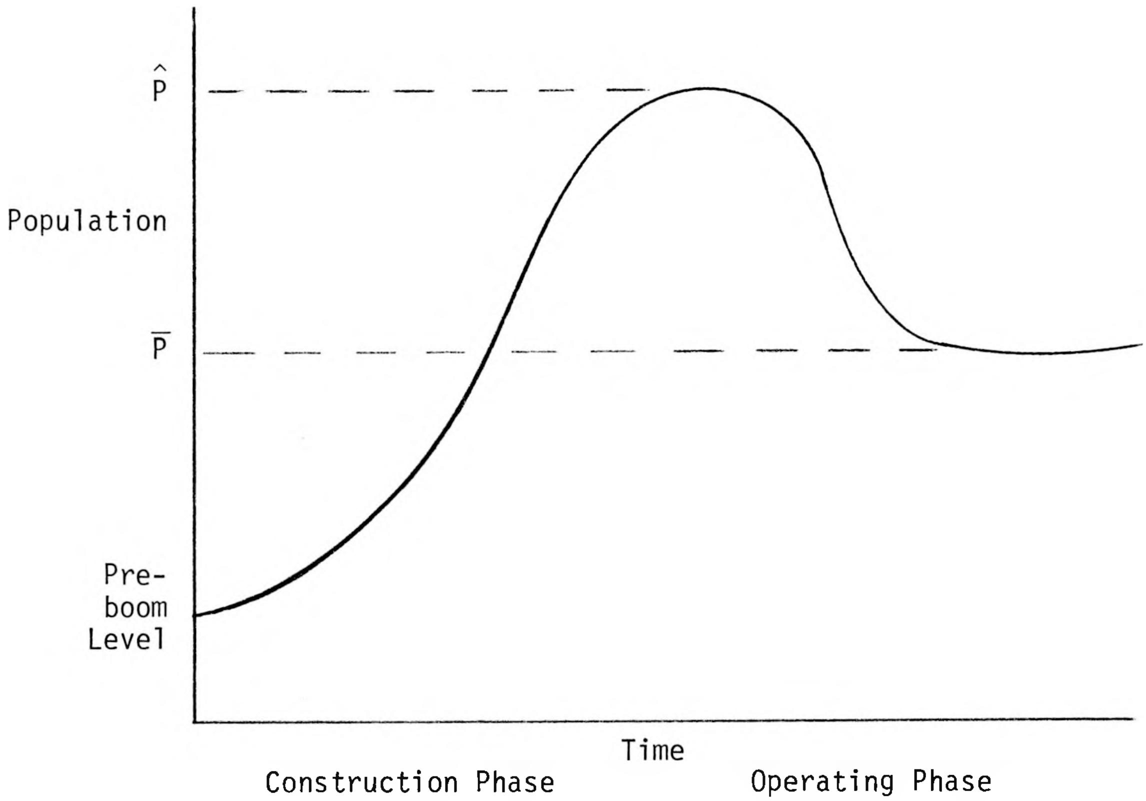

Figure 1.1
Characterization of a Boomtown

Somewhat naively, perhaps, the author's original intent for this dissertation was to attempt to develop an analytical framework for the decision environment described above. A moment's reflection (in retrospect) suggests, however, that lying at the very heart of this issue is the nature of social benefits and/or costs associated with the provision --or lack of provision--of urban infrastructure. The determination of capital costs for various kinds of infrastructure is a relatively straightforward task, although a wide range of budgetary problems (such as the "front-end" problem)[1] may not be so straightforward. The social ramifications, valuations, of more or less investments raises a number of conceptual/empirical problems, a treatment for which the current state-of-the-arts leaves one poorly prepared.

The focus of this thesis is therefore on an attempt to derive operationally significant measures for social benefits attributable to investments in urban infrastructure in boomtowns.[2] As is explained below, this effort centers primarily on the conceptual development and empirical testing of a basic proposition concerning wages and urban infrastructure which is somewhat new in the context developed here. Efforts here are therefore exploratory in nature-the author's concern is with the potential of his suggested methodology for developing benefit measures for use by investment planners in boomtowns.

The specific objectives of the dissertation are as follows. First, an overview is provided of the essential nature of this infrastructural investment problem as it relates to the need for measures of infrastructural-related benefits; problems associated with attempts to directly measure such benefits are discussed. Second, a basic proposition is formulated concerning a benefit measure for urban infrastructure. Third, data are collected which allow for the empirical testing of this

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[1]The "front-end" problem relates to the timing of revenues to the community. In most cases, a community derives tax revenue from such things as property and/or sales taxes. Thus, revenues from the energy development activity begin to flow only <u>after</u> the plant is in operation, which is to say at the end of the construction phase. Thus the need for pre-construction phase, "front-end" funds by the community.

[2]This statement gives rise to the obvious question as to why benefits attributable to social infrastructure in boomtowns should be different from those in other towns. This question is addressed in Chapter IV.

basic proposition. Finally, statistical models are formulated, and the potential of this basic proposition for deriving benefit measures for use in investment planning is assessed.

The plan of the dissertation is as follows. In Chapter II, attention is given to the first and second objectives. A review of the benefit measure problem is given and the basic proposition is developed. In Chapter III the structure and form of the linear statistical models to be used are discussed, and discussions are presented concerning the structure of the data. In Chapter IV the results from the statistical analyses are summarized and interpreted; an assessment of the potential of this methodology in deriving useful surrogates for social benefits attributable to urban infrastructure is also given. Concluding remarks and suggestions for future research are the topics of the final chapter, Chapter V.

CHAPTER II

BENEFITS ATTRIBUTABLE TO URBAN INFRASTRUCTURE: OVERVIEW AND AN ALTERNATIVE METHOD

2.A Introduction. In looking to the literature in Public Finance for an assessment of the current state-of-the-arts as it relates to measurements of benefits attributable to urban infrastructure, there appears to be general consensus that in this area little or no real progress has been made in the profession.[1] The essence of this consensus is aptly stated by Neenan as follows:

> The few studies that have attempted to evaluate government expenditures have notably avoided any attempt to measure benefits by effective demand. Instead, in such studies, benefits have typically been measured by the cost of providing the service. . . . Although neither measuring benefits by their cost nor allocating them by some arbitrary rule of thumb has been defended on theoretical grounds, they have been tolerated apparently under the belief that benefit measurement is a task eminently in need of doing and no other basis seems feasible.[2]

In section 2.B below, the author presents a survey of the conceptual and empirical problems associated with the notion of urban infrastructure (or urban services)[3] related benefits that give rise to the "eminent

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[1]See R.A. Musgrave, The Theory of Public Finance (McGraw-Hill, 1959), W.B. Neenan, Political Economy of Urban Areas (Markham Publishing Co., 1972), and W.P. Beaton (editor), Municipal Needs, Services, and Financing (Center for Urban Policy Research, Rutgers University, 1974). A great deal of attention in this literature, as it relates to the problem of interest here, is focused on issues related to justice in taxation and the relevant voting-political process; see Musgrave (cited above), Chapter 6, Neenan (cited above), pp. 85-86, and C. M. Tiebout, "A Pure Theory of Local Expenditures," Chapter 2, in Beaton (cited above).

[2]Neenan, op. cit., p. 84.

[3]For reasons described in section 2.B below most efforts in this area focus on aggregative (and somewhat nebulus measures) of such things as "services," "welfare," or "expenditures" rather than on infrastructure per se.

need" for further research in this area described by Neenan. These discussions include a description of economists' efforts to deal with such urban benefit problems, as well as a critique of the "requirements" approach to urban investment planning which is often used to fill the methodological void left by the absence of such measures.

In section 2.C, a conceptual line of argument is developed which results in a basic proposition concerning trade-offs between wages and urban infrastructure. It is suggested that this proposition might serve as a basis for efforts to generate defensible measures for infrastructures benefits that might fill the existing void. Statistical tests designed to permit an assessment of the potential of this suggested methodology are then the topics of the balance of this dissertation.

2.B Urban Infrastructure-related Benefits: The Problem of Measurement. Recent literature concerning efforts to come to grips with the benefits-to-infrastructure measurement problem focus on one or more of three major lines of argument. The first of these involves the notion of obtaining measures of individual preferences for urban services relative to other goods.[1] The essence of this approach, which is inextricably tied to the notion of voluntary exchange,[2] is that one might directly or indirectly obtain measures of what individuals in a community might be willing to pay (WTP) for alternative flows of urban services. Such WTP measures would then reflect each consumer's subjective valuation of urban services relative to other goods.

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[1]Musgrave, op.cit., pp. 73-86; Tiebout, op.cit.; and R.L. Ackoff, "Toward Quantitative Evaluation of Urban Services," in H.G. Schaller (ed.), Public Expenditures Decisions in the Urban Economy (Johns Hopkins Press, 1963), pp 91-117.

[2]Musgrave, op.cit., p. 86.

If such a schedule could be obtained for each individual in the community and then aggregated over all individuals a "community" WTP scheduled, such as that depicted in Figure 2.1, would be obtained where P measures the community's WTP, and Q the flow of urban services.[1] The provision of $\tilde{Q}$ services would then be associated with the generation of benefits in an amount equal to the shaded area inasmuch as this area measures the sum of the community's aggregated subjective valuation of increments from 0 to $\tilde{Q}$.[2]

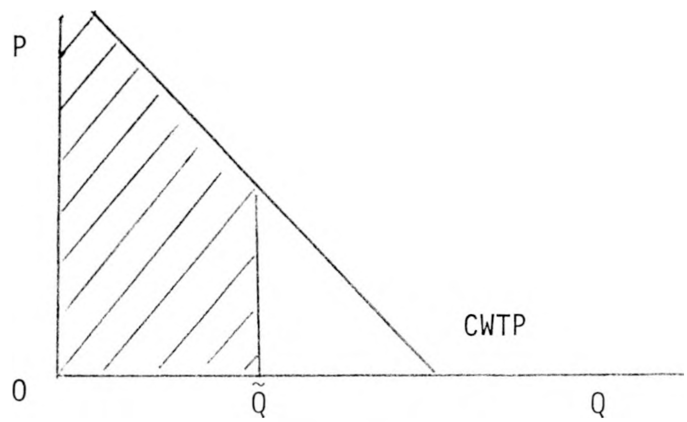

Figure 2.1

Community (WTP) Schedule

This approach is subject to a number of weaknesses. The most obvious weakness relates to the well-known problem of interpersonal

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[1]The negative slope given CWTP reflects the traditional assumption of individuals' diminishing marginal utility for Q.

[2]O.C. Herfindahl and A.V. Kneese, Economic Theory of Natural Resources (Merrill Publishing Co., 1974), pp. 246-267, and C.W. Howe, Benefit Cost Analysis for Water System Planning (American Geophysical Union, 1971), Chapter 6.

comparisons of utility which is succinctly stated, as it relates to this problem, as follows.

> Suppose we can determine the maximum amount of money that each member of a community is willing to pay for a public service. For each individual this would be the monetary equivalent of the value he places on the service. However, we cannot add these monetary values to obtain an aggregated measure of value to the community because the same amount of money may represent different amounts of value to different people. . . .
>
> This difficulty would disappear if we could measure the value of a service on an "interpersonal" or "absolute" scale of value, but no such scale is available yet.[1]

The interpersonal comparison issue notwithstanding, other writers object to the premise of individual evaluations of urban services *per se*. Adherents of the "organic theory of the state"[2] view public wants as being basically different from private wants, and therefore not appearing in private preference schedules for individuals. In this view, public goods relate to "group" needs which are in some (unspecified[3]) manner experienced by the group as a whole.

A variant of the "organic theory of the state" criticism is the position taken by some that the individual preferences approach ignores the essentially political character of the budget process involved in urban infrastructure decisions, and the *social* nature of objectives associated with such decisions.[4] This notion relates to the "voting" approach to benefit-measures which is discussed below.

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[1]Ackoff, *op.cit.*, p. 100.

[2]Musgrave, *op.cit.*, pp. 86-87.

[3]As stated by Musgrave, "Since the group as such cannot speak, one wonders who is equipped to reveal group feelings," Musgrave, *op.cit.*, p. 87.

[4]*Ibid.*

But even if one could dispense with the problems described above, the extremely perplexing problem of defining units of various types of urban services remains when one looks to the more specific issue of benefits attributable to flows of services from urban infrastructure.

Consider, for example, the notion of benefits attributable to investments in school facilities. Just what is the flow of services to school facilities? In the literature, such services are generally taken to be related to the "quality of education." While there is anything but agreement as to what "quality of education" might mean[1] or how it might be measured,[2] a number of recent studies concerning the quality of education take students' performance on examinations as an indicator of quality and attempt to correlate the quality of education with such things as class size, post-baccalaureate training of teachers, and physical school facilities (the component of urban infrastructure of interest here).[3] The most recent of these studies suggest that small (28 students or less) class sizes benefit only the disadvantaged students, while all other students' performances seem unaffected by much larger class sizes. In terms of physical school facilities, there seems to

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[1]For example, L.R. Tamplyn, Inequality: A Portrait of Rural America (Rural Education Assn., Washington, D.C., 1973); W. Mullenkopf and D. Melville, A Study of Secondary School Characteristics as Translated into Test Scores (Educ. Testing Service, Princeton Research Bulletin No. 56-6, 1956); and A.J. Thomas, "Efficiency in Education: A Study Sample of Senior High Schools," unpublished Ph.D. dissertation (Stanford University, Palo Alto, 1968).

[2]Tamplyn, op.cit.

[3]For an interesting legal controversy concerning the quality of education, see D. Rodriguez, et al., vs. San Antonio Independent Schools Districts, et al., U.S. District Court, Western Districts of Texas, 411 U.S. 1 (March '75); and Serrano vs. Priest, 5 Cal 3rd, 584, 487 p. 2nd, 1241-96 Cal. Reporter 601 (1971).

be little or no correlation between student performance and capital investments.[1]

But further, even _if_ one could identify a strong correlation between student performance and capital investments, the problem remains of translating altered performance (resulting from alternative investment programs) into some notion of benefits and/or costs. If examination performance increases (or decreases) by 5 percent, what happens? What are the benefits and to whom do they accrue?

This line of inquiry can quickly lead one into a morass of philosophical and value-related issues which have been discussed at considerable length by others.[2] In the end, one is left with no logically consistent, defensible way by which to associate (or indeed, define) cost or benefits with alternative levels of capital investments in educational facilities--_including_ that level consistent with oft-times legally-determined standards.[3] Economists' frustrations, stemming from these problems, are reflected in Ackoff's lament:

> In my efforts to construct a measure of the value of the output of educational services I ran into a great deal of trouble. The output seems more complex and intangible than any of the other services I considered, including a number that are not discussed here. The difficulty persisted and did not seem to dissipate with reflection. An examination of the relevant literature showed that others had found this same difficulty. . . .

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[1]A. Summers and B. Wolfe, _Some School Resources Help Some Students to Learn, But Which?_ (_Tax Review_, Vol. XXXVI, No. 9, Tax Foundation, New York, September 1975), pp. 37-40.

[2]J.W. Guthrie _et al._, _Schools and Inequality_ (Cambridge: MIT Press, 1971); and particularly J. Coleman _et al._, _Equality of Education Opportunities_ (Washington, D.C.: U.S. Office of Education, U.S. Government Printing Office, 1966).

[3]Rodriguez vs. San Antonio Independent Schools, _op.cit._

> The impression one gets from these discussions is that the extrinsic value of education might conceivably be measured, but its intrinsic value probably cannot be, at least at the present time. Although it seems clear to me that education has a value which falls outside the realm of economics, it is not clear what these other values are and how they can be measured.[1]

These kinds of problems apply equally well to many other kinds of infrastructure. In the case of municipal parks (recreation), a measure analogous to the distance surrogate for price most often used in recreation studies is not immediately obvious. In the case of public safety facilities, one might attempt to correlate property losses to levels of such facilities, but one then misses a potentially substantial benefit attributable to such facilities: reduced loss of life.[2]

Aggregative Measures of Benefits. A second line of argument concerning benefit measures for urban infrastructure involves the use of aggregative cross-sectional data in an effort to infer benefits (demand) received by communities from urban infrastructure. Using cross-sectional data (across cities), studies in this category[3] are characterized by attempts to "explain" variations in levels of urban (total) expenditures by such variables as income, population density, non-urban dwellers, and per capita federal grants to states, among others.[4]

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[1]Ackoff, op.cit., p. 110.

[2]W. C. Birdsall, "A Study of the Demand for Public Goods," in Essays in Fiscal Federalism, ed. by R. A. Musgrave (Brookings Institution, 1965), pp. 240-246.

[3]See Neenan, op. cit., Chapter 4; Tiebout, op.cit.; J.M. Henderson, "Local Government Expenditures: A Social Welfare Analysis," Review of Economics and Statistics, Vol. 54, No. 2 (May 1968), pp. 156-163; and J.C. Ohls and T. J. Wales, "Supply and Demand for State and Local Services," Review of Economics and Statistics, Vol. 50, No. 3 (Nov. 1972), pp. 424-430.

[4]Ohls and Wales, op.cit.; and Henderson op.cit.

There is considerable dissatisfaction with efforts of this stripe (aside from their non-applicability to the more narrow infrastructure argument *per se*), however, for two major reasons. First, observed municipal expenditures reflect budget constraints, which are often quite restrictive. (This would be particularly true in boomtowns.) Thus, one has no assurance at all that, given values for the independent variables, the given level of expenditures reflects the maximum amount that the aggregative community would be willing to pay for that (implicit) level of services.

Second, even if the "quantity" of such dependent variables as public safety were determinable, they could not be explained by *variables* which differ among individuals, since the dependent variable is a constant among individuals (with a variance of zero). Thus we must view as suspect any deductions from results of studies that attempt to measure benefits based on variations in levels of (total) urban expenditures. Indeed, it would seem that the structure of such studies might be most compatible with the earlier-mentioned "organic theory of the state."

Voting as a "Signal" of Benefits. The third line of argument concerning benefits which deserves brief mention is related to the earlier notion that, in the end, urban investment decisions are best viewed as unrelated to individual preferences and simply determined by the political process where "group" feelings are expressed by votes.[2]

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[1]This point is taken from Birdsall, *op.cit.*, pp. 240-243.

[2]Musgrave, *op.cit.*, p. 87.

While there are many variations of this line of argument,[1] the essential inquiry concerns the manner by which consumer-voters, as a group, register their preferences for public goods. Governments' revenue-expenditure patterns are expected to adapt to the preferences of this group. This logic implies that *if* all consumer-voters could *somehow* be forced to reveal their preferences (via votes?), then the governments' production of goods (and therefore investments in infrastructure) and the appropriate tax could be determined.

The major logical problem with this approach is that there is no way to force consumer-voters to reveal their preferences. Indeed, as suggested by Tiebout,[2] the rational consumer may well understate his preferences in the hope of acquiring more goods with lower taxes.

The infant stages of this line of argument are best expressed by the following statement by Tiebout:

> It is (my) contention that, for a substantial portion of . . . public goods, this problem *does have* a conceptual solution. . . . (quoting Samuelson) *the solution* 'exists'; the problem is how to 'find' it.[3]

The "Requirements" Approach. Given the myriad problems associated with attempting to measure (indeed, to *define*) benefits attributable to urban infrastructure--a prerequisite to any benefit maximization framework--investment planners concerned with many kinds of infrastructure

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[1]R.A. Musgrave, "The Voluntary Exchange Theory of Public Economy," *Quarterly Journal of Economics*, Vol. 52 (February 1939), pp. 213-217; and P.A. Samuelson, "The Pure Theory of Public Expenditure," *Review of Economics and Statistics*, Vol. 36, No. 4 (November 1954), pp. 387-389.

[2]Tiebout, *op.cit.*, p. 32.

[3]Tiebout, *op.cit.*, p. 40.

problems have seen little alternative to the use of cost minimization techniques with the use of "requirements."[1] Given its widespread use, a brief critique is given the method for completeness.

The essence of the "requirements" method is, first, to determine (usually on a per capita basis) requirements α_i for each investment-related service i, i = 1 ..., I (e.g., classrooms per child or unit of population, water system capacity per capita) and alternative capital items j, j = 1 ..., J, which may provide flows of the service i (e.g., i = education--classrooms, j = 1: brick school buildings, j = 2: temporary structures, trailers). Then, for a given time-path of requirements, investment alternatives j (with associated depreciation rates) are chosen such that the present value of investment costs is minimized.[2]

Formally, if P^t is population (estimated) in period t (t = 1 ..., T), K_j^t the stock of type j capital at the beginning of t, $d_j(K_j^t)$ periodic depreciation of j-capital, I_j^t periodic investments in j-capital at costs $C_j^t(I_j^t)$, α_i^t periodic flows of i-service from j-capital, and r the discount rate, the standard cost minimization approach has the following simplified structure.

$$\text{Min.} \sum_{t=1}^{T} \sum_{j} C_j^t \, (I_j^t) \, (1+r)^{-t} \tag{2,1}$$

$$\text{subject to: } K_j^{t+1} = K_j^t + I_j^t - d_j \, (K_j^t), \; j = 1 \, \ldots, J \tag{2,2}$$

$$I_j^t \geq o \tag{2,3}$$

---

[1]A review of these studies is given in Richard Frye, "Inter-basin Transfers of Groundwater for Municipal Supply: A Case Study in Rhode Island" (unpublished Ph.D. dissertation, University of Rhode Island, 1975, Chapter. 2.

[2]Frye, op.cit., p.21.

$$\sum_j \alpha_{ij}^{t} K_j^t \geq \alpha_i P^t \quad , \; i = 1 \ldots, I \qquad (2.4)$$

Equation (2.2) describes the intertemporal transition of capital stocks, which increase with periodic investments and decrease with depreciation.[1] Equation (2.4) requires that the flow of service i from (possibly) all capital stocks j (α_{ij} K_j) be at least as great as the required flow $\alpha_i p^t$ for all periods t. Capital stocks j are then chosen such that the requirements (2.4) are met at minimum present value costs (equation 2.1).

In systems of the type (2.1)--(2.4) there are imbedded two particularly crucial assumptions. First, the municipality wishes to maintain "required" infrastructural levels (inequality 2.4) at any cost; i.e., tacitly there are no trade-offs between required or norm levels of infrastructural-related services and other socio-economic quantities (income, tax burdens, etc.). The opportunity cost of investment funds is reflected only in the objective to minimize costs; one cannot speak to the relative costs of accepting $\alpha_i P - \varepsilon$ (ε is arbitrarily small) levels of social infrastructure in lieu of incurring investment costs $\partial C/\partial I$ to attain $\alpha_i P$.[2]

Second, the social ramifications of providing capital stocks in excess of required levels (inequality holds in (2.4)) are ignored. If one looks at the system (2.1)--(2.4) in a context where variables are not

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[1]This implies a "decay" type of depreciation. Other forms are of course possible; e.g., a use-rate determined rate of depreciation. See O.R. Burt and R. G. Cummings, "Production and Investment in Natural Resource Industries," American Economic Review, 60, 4(1970), pp. 576-90.

[2]These costs may be quite large, particularly in instances where changes in capital stocks must be viewed discretely.

continuous (using a discrete programming statement), it is entirely possible that a given investment program will result in "excess" stocks obtained over various intervals of time. One would be indifferent between this program and one where inequality in (2.4) holds for each t with this approach so long as the value of (2.1) was the same for both investment programs.

Of course, assumptions of these kinds give rise to particular discomfort under boomtown conditions wherein demands for infrastructure are peaked (Figure 1.1), and the satisfaction of (2.4) for peak periods immediately implies inequality in (2.4) (excess capital stocks) for the post-boom period.

It should be reiterated that the above is not intended to argue that those who have used this "requirements" approach are unaware of these weaknesses; the above criticisms are generally well understood in the profession.[1] The use of this approach most often simply reflects the fact that it is viewed as the only game in town; i.e., defensible measures for the benefits/costs associated with infrastructure-levels more or less than required levels simply may not exist.

2.C An Indirect Measure for Social Benefits. The author's initial efforts to derive estimates directly for infrastructure-related benefits were essentially focused on searching for surrogates for individuals' preferences as they relate to the valuation of urban infrastructure (e.g., relating drop-out rates and test scores to educational facilities), and Ackoff's frustrations (page 14, footnote 1) were deeply shared. A

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[1]Frye, op.cit., Chapter 2.

suggestion by Professor Ralph d'Arge, however,[1] set the author to thinking about a possible alternative approach involving an indirect measure for (preference-related) individuals' subjective valuations of urban infrastructure in boomtowns which might serve as a useful measure for municipal planners. While the method to be investigated here shares many of the problems of methods described above as well as introducing many of its own, it does relieve the analysis of some of the more objectionable ones found in earlier cross-sectional studies (the disaggregative problem). The particularly thorny problem encountered in attempting to evaluate urban infrastructure specifically--that of specifying benefits in terms of units of the infrastructure-related flow of services --is also avoided.

The approach of interest here is suggested by the recent works of Dr. Irving Hoch.[2] In these works, Dr. Hoch examines the following hypothesis:

> Other things equal, people in large places prefer smaller places. But other things are not equal, and income in large urban areas is enough higher than that in the smaller places to attract and keep people in those larger places.[3]

The primary cause of people's preference for smaller areas is that,

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[1]The author is deeply indebted to Professor Ralph d'Arge, University of Wyoming, for his suggestions which led the author to this line of inquiry.

[2]Irving Hoch, Urban Scale and Environmental Quality in Population Resources and the Environment, ed. by R.G. Ridker. Research Reports, Vol. III, Commission on Population Growth and the American Future (Washington, D.C., 1972); and Irving Hoch, "Variations in the Quality of Urban Life Among Cities and Regions," presented at the International Research Conference on Public Policy and the Quality of Life in Urban Areas, New Orleans, La., January 2-7, 1975.

[3]Hoch, op.cit., 1972, p. 235.

generally, in larger areas, there has been a degradation of environmental quality and, according to Hoch,[1] the larger the area the lower the quality.

The potential relevance of Hoch's position for the infrastructure problem is immediately apparent from the following restatement of his basic hypothesis: a wage differential between large and small areas is explained by differences in the quality of life, and "quality of life" differentials are measured (or in large part determined) by differentials in environmental quality. In terms of the boomtown problem, the comparison analogous to Hoch's large-small area might well be viewed as a boomtown-stable (base) town comparison, and a major determinant of quality of life differentials between boom and base towns may be taken to be differentials in urban infrastructure. Such a position would be clearly supported by the findings of a recent survey on boomtowns, wherein it is concluded that ". . . the quality of sanitation services, road and street maintenance, . . . schools and shopping facilities (in the Rock Springs, Wyoming boom community) . . . were deemed low enough that each justified leaving the community in the opinion of one-third of the newcomer households queried."[2]

These arguments suggest the following theoretical line of reasoning. Assume that an individual's utility function has the form:

$$U(w,k),\ U_w,\ U_k \geq 0,\ U_{ww},\ U_{kk} \leq 0. \qquad (2.5)$$

In (2.5) w is the wage received by the individual, and k is per capita

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[1] Ibid.

[2] John S. Gilmore, "Boomtown May Hinder Energy Resource Development," Science, Vol. 191 (February 13, 1976), pp. 535-540.

infrastructure in the community in which the individual resides. Let w_n, k_n be the wage and per capita infrastructure available to the individual in a non-boomtown community. A plausible requirement for the individual to migrate to the boomtown community is that the wage and per capita infrastructure in the boomtown community satisfy the inequality

$$U(w,k) \geq U(w_n, k_n). \tag{2.6}$$

With equality in (2.6) it follows that

$$U_w dw + U_k dk = 0, \tag{2.7}$$

$$dw = -\frac{U_k}{U_w} dk. \tag{2.8}$$

Equation (2.7) then provides a formal statement of the resulting trade-off between wages and social infrastructure. A given change (e.g., reduction) in infrastructure must be offset by a change (positive) in wages determined by the individual's marginal rate of substitution between wages and per capita infrastructure.

The form of (2.8) suggests a structure for a proposition, hereafter referred to as the "basic proposition," relating w and k which is amenable to statistical testing, viz., the following form.

$$w^* = \beta k^*. \tag{2.9}$$

In (2.9), reflecting the condition (2.6), w^* and k^* are differences between boomtown and stable town wages and levels of per capita infrastructure.

Equation (2.9) is used as a basis for forming and testing alternative hypotheses as to the relationship between wage differentials (in boomtown relative to a specified base town) and differentials in per capita infrastructure described in Chapter III, below. Given the problems attending efforts to directly measure infrastructure-related benefits discussed in section 2.B, the intent here is to inquire as to the possibility of indirectly deriving subjective measures of such benefits. In other words, if statistical analyses support relationships of the form given in (2.9), β may be taken as a measure of individuals' "revealed" subjective trade-off between w and k, and might then (under conditions which will be developed below) serve as a surrogate for social benefits attributable to social infrastructure for use by investment planners.

As is discussed in Chapters III-V, below, a wide range of conceptual and empirical problems is encountered in efforts to test the basic proposition. Given discussions earlier in the present chapter regarding weaknesses of other efforts to generate benefit measures, it seems appropriate to comment at this point as to how use of the basic proposition suggested here might represent any improvement over other methods.

Reviewed methods for estimating benefits and their major weaknesses, as discussed above, may be summarized as follows:

A.	Individual Preferences:	A.1.	Interpersonal Comparisons of Utility
		A.2.	Defining benefits in units of infrastructure
B.	Cross-sectional:	B.1.	Influence on measures of city budget constraints
		B.2.	Benefit-service flow observations are not variables
C.	Voting:	C.1.	Consumer-voters do not reveal preferences.

With reference to B.1, the influence of budget constraints on values of k* (in 2.9) would introduce no inconsistencies inasmuch as the determination of k*-levels is not at issue. Interest here is on the impact of given values of k* on w*; the benefit-flow problem (B.2) is clearly not a problem, nor is C.1 *ipso facto* a weakness.

The major weakness *retained* here concerns the problem of interpersonal comparisons, A.1. There are no *a priori* grounds for assuming that observed wages, determined by the *marginal* worker under competitive market conditions, would in any way reflect valuations of infrastructure (relative to income) by other individuals. This issue is pursued in some detail in Chapter V as it relates to pre-boom and post-boom populations.

The major strength of this approach (in the author's opinion) relates to A.2. As posited here, labor requires a wage differential to compensate for infrastructure differentials *as the laborer perceives* these differentials. One is not required to specify the nature of the flows of services attributed to educational facilities, as they are then to be evaluated.

As is pointed out above, this latter problem is a major one which has discouraged many efforts to assess the valuation of urban services,[1] leading to the assertion that simply too many "intangibles" are involved. Therefore, an assessment of the methodology offered here is in the spirit of Ackoff's observation that ". . . to argue (that too many intangibles are involved) is to fly in the face of history which has shown that in each age the intangibles of preceding ages are made tangible."[2]

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[1]Ackoff, *op.cit.*, p. 93.

[2]*Ibid.*

CHAPTER III

STATISTICAL METHODOLOGY, MODEL SPECIFICATION, AND DATA

3.A Introduction. In this chapter the structural forms of the linear models to be estimated are specified, after which a description of data and related problems are presented. A summary of notations used in the discussions below is given in Table 3.1.

3.B Structural Forms of Linear Models. In this section the structural forms of the linear models to be estimated are specified. It is proposed that, at the margin, a wage differential is required to compensate workers for the difference in the "quality of life" between boomtowns and a base town. That is, in order to attract labor to the boomtown community, labor must receive their "base" wage plus a premium which reflects differences in the quality of their living environment (relative to the base community). Surrogates used to measure "quality of the living environment" are initially taken to be per capita infrastructure and the boomtown community's relative distance from a metropolitan area (a surrogate for relative isolation). It is acknowledged that there is a wide range of other arguments that might well be relevant for "explaining" wage differentials between base and boomtown communities, some of which are discussed in the concluding chapter. The initial proposition is simply a tool for initial efforts to determine whether or not we can indeed identify a subjective valuation by individuals of urban infrastructure.

TABLE 3.1

Notation Used in Chapter III

w_n	Weekly wages (1965 dollars) in base town.
w_b	Weekly wages (1965 dollars) in boomtown.
w^*	$w_b - w_n$
k_{ni}	Per capita infrastructure of type i in the base town. i = 1 for educational facilities 2 for public safety 3 for water/sewage 4 for recreational facilities 5 for "all other"
k_{bi}	Per capita infrastructure of type i in the boomtown.
k_i^*	$k_{bi} - k_{ni}$
K_{ib}^t	Total infrastructure of type i in boomtown b at the beginning of year t.
I_{ib}^t	Investments in type i infrastructure in boomtown b during year t.
P_b^t	Population in boomtown b in year t.
D_n	Distance (in miles) of base town from Albuquerque, El Paso, or Denver.
D_b	Distance (in miles) of boomtown b from Albuquerque, El Paso, or Denver.
D	$D_b - D_n$
E	Percent change in boomtown employment from previous year.
U_{bt}	An error term assumed to be distributed as $n(0,\sigma^2)$.

w^* is defined as the difference in wages between boomtowns and the base community, k_i^* as the differential in per capita urban infrastructure (of type i; e.g., educational facilities, public safety, water and sewage, recreational facilities, other) between the boomtown and base community, D* as the differential in terms of distance to the nearest metropolitan area (Albuquerque, El Paso or Denver, in this study), and E as the percentage change in employment from the preceding year in the boomtown (a variable used to reflect instability in labor markets).

There are basically two sets of linear models which are utilized. The first is between the wage difference w^* and the sum of the capital stock differences, $\sum_{i=1}^{5} k_i^*$, the distance to the nearest SMSA, and the percentage change in employment from the preceding year, E. Two equations are fitted--one utilizing only linear values for the independent variables and the second utilizing linear and quadratic. These two equations are:

$$w^* = \beta_1 + \beta_2 \sum_{i=1}^{5} k_i^* + \beta_3 D + \beta_4 E + u; \qquad (3.1)$$

$$w^* = \beta_1 + \beta_2 (\Sigma k_i^*) + \beta_3 (\sum_{i=1}^{5} k_i^t)^2 + \beta_4 D + \beta_5 D^2 \qquad (3.2)$$

$$+ \beta_6 E + \beta_7 E^2 + u.$$

To facilitate the reader's appreciation of the manner in which data used (described below) relate to the form of the linear models, equation (3.1) is restated as follows in the form for which data are used.

$$w_{bt}^* = \beta_1 + \beta_2 \sum_{i=1}^{5} k_{ibt}^* + \beta_3 D_b + \beta_4 E_b + U_{bt} \qquad (3.1)$$

$b = 1, 2, . . ., 28.$

t varies according to b (Table A in Appendix)

$U_{bt} \sim n(0, \sigma^2)$

The second set tests the relationship between w^* and <u>each</u> of the capital stock differences, the distance to the nearest SMSA, and the percentage change in unemployment, E. Two equations are again fitted wherein one is based on linear values for the independent variables and the other is based on linear and quadratic values. The second set of equations is given as follows.

$$w^* = \beta_1 + \sum_{i=1}^{5} \beta_{i+1} k_i^* + \beta_7 D + \beta_8 E + u; \qquad (3.3)$$

$$w^* = \beta_1 + \sum_{i=1}^{5} \beta_{i+1} k_i^* + \sum_{i=1}^{5} \beta_{i+6} k_i^{*2} \qquad (3.4)$$

$$+ \beta_{12} D^* + \beta_{13} D^2 + \beta_{14} E + \beta_{15} E^2 + u;$$

Two types of hypotheses are tested here. One involves the entire β vector in equations (3.1) - (3.4), and the other involves the individual components of the β vector. The first hypothesis is of the form

$$H_0 : \beta = 0 \text{ versus } H_A : \beta \neq 0,$$

were H_0 is the null hypothesis and H_A is the alternative hypothesis.

The second hypotheses concern each of the β_i's and are of the following general form:

$$H_0 : \beta_i = 0 \text{ versus } H_A : \beta_i \neq 0.$$

With reference to the alternative hypotheses in this second set of hypotheses, the β_i's associated with capital stock differentials (the k_i^*'s) are hypothesized to have specific signs. Specifically, $\beta_2 < 0$ in (3.1) and (3.2), and $\beta_3 > 0$ in (3.2); $\beta_i < 0$ for i = 2,3, ..., 6 in (3.3) and (3.4), $\beta_i > 0$ for i = 7,8, ..., 11 in (3.4).

Before moving on to a description of the data, a few observations concerning the conceptual structure of the hypotheses described above are in order.[1] First, a major potential conceptual problem is related to the fact that the causal relationship between wages and movements in the labor supply, E in equations (3.1) - (3.4), may in fact be of a different form. In particular, one may hypothesize that markets in all other areas determine the wage, and that in-migration of labor to the boomtown, as measured by E, is determined by the wages, W; (i.e., E=E(W)). Or if, as argued above, a trade-off exists between wages and capital stocks, then E would be determined by W and K.

The inclusion of E in the linear models presented above is for the purpose of introducing a variable which might serve as a measure for disequilibrium conditions in boomtown labor markets.[2] In other words, referring to Figure 3.1, with the introduction of a coal mining (or other energy development) activity, the value of labor's marginal product in the boomtown may shift from VMP_1 to VMP_2. In the short-run, competition for labor supplies would then force the wage from W_1 to W_2, ceteris paribus. Over time, with adjustments for capital stocks, market wages may then fall to W_3 (reflecting the condition $U(w,k) = U^*(w^*,k^*)$ as argued in Chapter II). The wage differential of interest here would then be W_3-W_1, not W_2-W_1. The W_2-W_3 differentials would simply reflect short-run disequilibrium conditions in the local labor market.

The percentage change in boomtown employment, E, is then introduced as a surrogate for disequilibrium labor market conditions, and in doing so introduces the possible structural problem described

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[1]The author is indebted to Professor Kenneth McConnell, University of Rhode Island, for his suggestions in this regard.

[2]The disequilibrium issue was a major problem of concern to Professor Hoch; appreciation is expressed to Professor Hoch for his suggestions regarding this matter.

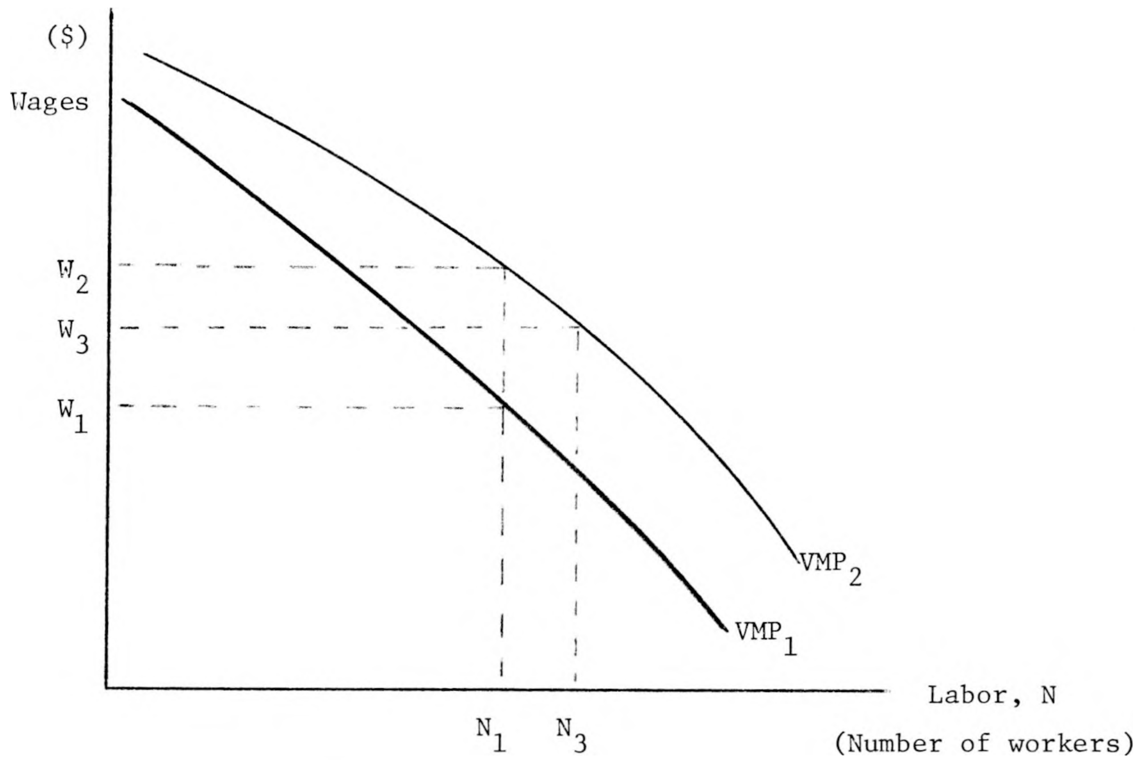

Figure 3.1

Representation of Value of the Marginal Product of Labor

above. Little more can be said at this time other than that in future research one may be well advised to look for other surrogates for disequilibrium, and that the issue of labor force movements as a function of wages may deserve considerably more attention.

Finally, one may argue in a manner analogous to the E(w) argument above, the demand for urban infrastructure is causally related to income-levels and, therefore, wages. Thus, K=K(w), and the appropriate causal relationship is of a different form than that posited in equations (3.1)-(3.4). Such an alternative form has considerable appeal, particularly in terms of the notion that many urban infrastructure-related amenities (e.g., an opera, or large libraries) may be related to scale.[1]

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[1]Hoch, op.cit., 1973, p. 235.

Given the relatively small size of the great majority of the boomtown communities considered in this work, this problem may not be particularly relevant. Potential weaknesses of results presented as they relate to the K=K(w) problem should be kept in mind, however, and the issue certainly warrants further consideration in future works.

3.C. Data. Given the resource limitations, it was necessary to limit the search for data primarily to secondary sources in the archives of the Bureau of Business Research at the University of New Mexico, although some data were acquired during two short field trips to Colorado, Wyoming and Northwest New Mexico.[1] In what follows, a description of the data used for testing the hypotheses (3.1)-(3.4) is given. A discussion of the problems and potential biases implicit to the use of these data is presented in Chapter V to the end of identifying and/or suggesting ways in which better data might be obtained for use in future research.

In the discussions below, neither base towns nor boomtowns are identified by name inasmuch as state disclosure laws are applicable to some of the data used in this study.

The first set of data required relates to wages and per capita urban infrastructure for the base town(s). Taking into consideration the possible effect of town size on wages and infrastructure, towns are classified A, B, or C according to population ranges: "A" towns have populations between 0-3,000; "B" towns 3,001-15,000; and "C" towns are above 15,000 (see Table A in Appendix). Two New Mexico towns in each population class

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[1]Financial support for these trips was provided by the Los Alamos Scientific Laboratory.

were chosen as being "normal," non-boomtown communities which experienced rates of population growth of -3 percent to +3 percent during the 1965-74 period. These towns were subjectively chosen as being representative of stable communities from which labor might be attracted for work in boomtowns.

For each base town, annual investment expenditures for each of the five infrastructure categories[1] for the period 1965-74 were taken from individual town budgets and adjusted to 1965 dollars. The assumption was made that the quality and quantity of urban infrastructure in these towns were constant over this period, in which case reported real (1965 dollars) investment expenditures were viewed as simply those required to maintain depreciating stocks. Assuming an annual depreciation rate of 2 percent, average annual investment (depreciation) expenditures are then capitalized to obtain an estimate of 1965 capital stocks for each type of infrastructure. Dividing this stock by each town's 1965 population yields per capita infrastructure for each base town. For each population class, the two-town average of per capita infrastructure is used to represent base town per capita infrastructure as given in Table 3.2.[2]

Average 1965 weekly wages for the six base towns were computed for mining and construction activities, and are reported in Table 3.2.

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[1]As described above, these categories are education, public safety, water/sewage, recreation and "all other." "All other" capital expenditures include primarily such things as cemeteries and general government.

[2]A problem which we have yet to attempt to deal with concerns the possibilities of economies of scale associated with urban infrastructure. Our limited data, used for the structure of base towns given in Table 3.2, suggest such scale economies A number of authors, however, argue that such economies are non-existent. (See, for example, W.E. Morgan and M.M. Hackbart, "An Analysis of State and Local Industrial Tax Exemption Programs," So. Econ. J. (October 1974), pp. 200-205.)

TABLE 3.2

Base Town Characteristics

Per Capita Infrastructure (1965 Dollars)

Population Level	Education	Public Safety	Water/ Sewage	Recreation	"All Other"
0-3000	$425	$245	$200	$ 75	$350
3001-15000	650	167	184	109	350
15000-over	474	140	184	114	350

Base-Town Weekly Wages for:	Year	Mining	Construction
	1965	$118.73	$105.30

Source: Capital Infrastructure data for New Mexico were computed from town budgets, and New Mexico School Financial Reports from Data Bank at UNM.

Wage data were computed from the Covered Employment Data published by the Employment Security Commission in both New Mexico and Colorado.

Mining and construction wages were chosen following the reasoning that the sharpest measure of the (marginal) infrastructure-wage trade-off would come from the types of employment undergoing the most rapid change in boomtowns.[1] It was then assumed that labor's productivity in these occupations is constant over the 1965-74 period, in which case the real opportunity cost of labor (the wate in U*(w*,k*)) is the average 1965 wage in the six base towns.[2]

If k_{ni} (i=1, ..., 5) and w_n are i-type per capita infrastructure and wages (1965 dollars) in the base town, one then requires analogous measures k_{bi} and w_b extant in boomtowns in order to calculate the *differentials* in wage and urban infrastructure which are the measures required in (3.1)-(3.4), and it is to the derivation of these measures that attention is now turned.

Twenty-eight towns in New Mexico (19) and Colorado (9) were identified as having experienced boom periods over the interval 1965-74.[3] These towns, and the periods used as "boom-periods," are given in Table A in the Appendix. It is important to recognize that there is *no* relation between the order of towns listed in Table A and the order of towns for which data are presented in Appendix Table B.

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[1]As is pointed out in Chapter V, the author has since discovered that this choice may have been a poor one given that these are highly unionized activities, and wages are generally fixed by the unions.

[2]This assumption is palatable for coal mining employment wherein output per hour has remained relatively constant--92.4 (1967=100) in 1965, 102.7 in 1970, 92.0 in 1972, and 92.2 in 1973. See the *U.S. Fact Book*, Bureau of the Census, Department of Commerce (Washington, D.C., 1976, p. 358). The assumption may be much stronger for construction workers, however.

[3]There is no single standard that may serve to identify a boomtown (see Gilmore, *op.cit.*, 1976). For the purposes of this study, towns with annual rates of population increase in excess of 5 percent were included.

For each town, wages were compiled for each year of the boom-period and deflated to 1965 dollars. The decision as to whether to use mining or construction wages in each town is based on the occupation which experienced the fastest rate of growth during the boom period. The differences between these wages and base town wages are listed in Table B located in the Appendix.

In terms of capital stocks for each type of urban infrastructure, each boomtown is given base town per capita urban infrastructure for the pre-boom year (which may vary from boomtown to boomtown--see Table A). Thus, each boomtown enters the boom period with total stocks equal to the per capita stocks given in Table 3.2, multiplied by the boomtown's pre-boom-period population.

In contrast to the treatment of investments in base towns wherein investment was viewed as simply the replacement of depreciated capital, periodic investments (taken from town budgets and school financial reports) for boomtowns are assumed to be net additions to capital stocks. This distinction is admittedly arbitrary, and reflects the notion (based on discussions with town planners) that boomtown communities replace few facilities, adding to outdated facilities whenever possible in an effort to stretch out the flow of urban services as best as possible to keep up with the rapidly expanding population.

In the pre-boom period, initial, total capital stocks (of type i in a boomtown, b, b=1, ..., 28) were calculated in the manner described above. Periodic stocks during the boom period are calculated as follows:

$$K_{ib}^{t} = k_{ib}^{t-1} P_{b}^{t-1} \quad (1-.02) + I_{ib}^{t-1} \qquad (3.5)$$

k_{ib}^{t-1} is per capita stocks in t-1, P_{b}^{t-1} is town b's population in t-1, and I_{ib}^{t-1} is capital investments for i-capital in town b in t-1.

Last period's (t-1) stocks are depreciated at 2 percent. Per capita stocks in t, k_{ib}^{t}, are thus K_{ib}^{t}/P_{b}^{t}, and the capital-stock differentials used for the regressions (3.1)-(3.4) are given by:

$$k_{ib}^{*t} = k_{ib}^{t} - k_{in}^{t} \qquad (3.6)$$

These data are given in Table B.

Population data, required for the calculation of per capita stocks, were extremely difficult to obtain. Published population data for municipalities are generally only available for census years (1960 and 1970) and 1973, during which year estimates of municipal populations were prepared for revenue sharing areas.[1] For years other than 1960, 1970, and 1973, population estimates were developed as follows: population: school enrollment (primary and secondary) ratios were computed for 1960, 1970, and 1973 for each town. These ratios for 1961-69 and 1971-73 were estimated by interpolation. Using published school enrollment data,[2] population estimates were the product of known school enrollment and the population:enrollment ratios.

Distances from all towns to major metropolitan areas (El Paso, Denver, or Albuquerque) were obtained from the American Automobile Association. Differentials in such distances between base and boomtowns are given in Table B. Changes in employment, E, were calculated directly from town employment data, and are also given in Table B.

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[1]U.S. Department of Commerce, Bureau of the Census, Social and Economic Statistics Administration, "Current Population Reports, Federal-State Cooperative Program for Population Estimates," Series P-26, Colorado and New Mexico, June 1975.

[2]*Op. cit.*

CHAPTER IV

ANALYSIS AND INTERPRETATION OF RESULTS

4.A Introduction. This chapter presents estimates of the β's, F-statistics, t-statistics and R^2's for equations (3.1), (3.2), (3.3) and (3.4). This information is then interpreted in light of the basic proposition stated in Chapter II. These results were obtained using the Statistical Package for the Social Sciences (SPSS) on a Control Data Corporation CDC 6600 Computer at the University of California's Los Alamos Scientific Laboratory.

4.B Analysis and Interpretation of Results. The following equations were obtained when equations (3.1)-(3.4) were estimated using data on 28 towns (132 sets of observations)* in New Mexico and Colorado. The values in parentheses under the regression coefficients are the t-statistics. The R^2 and F-statistics for each equation are also given below each equation. In the discussions that follow, the criterion for accepting or rejecting the hypotheses set out in Chapter III is as follows: coefficients β_i are accepted as being "significantly" greater than zero with associated t-statistics greater or equal to $(\pm)2.5$.

$$w^* = \underset{(2.6)}{12.} - \underset{(-3.6)}{.04}\left(\sum_{i=1}^{5} k_i^*\right) + \underset{(5.9)}{.17D} - \underset{(-.5)}{.014E} \qquad (4.1)$$

$$R^2 = .30$$

$$\text{F-statistic} = 17.96$$

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* As listed in Table B (Appendix).

$$w^* = \underset{(-1.2)}{-9.6} - \underset{(-2.5)}{.049}\left(\sum_{i=1}^{5} k_i^*\right) - \underset{(-.25)}{.00001}\left(\sum_{i=1}^{5} k^*\right)^2 - \underset{(-1.1)}{.05D}$$

$$+ \underset{(6.2)}{.002D^2} + \underset{(2.5)}{.2E} - \underset{(-2.6)}{.003E^2} \qquad (4.2)$$

$R^2 = .5$

F-statistic = 20.66

$$w^* = \underset{(1.7)}{7.8} - \underset{(-3.9)}{.17k_1^*} - \underset{(-2.8)}{.25k_2^*} - \underset{(-1.1)}{.04k_3^*} - \underset{(-.2)}{.04k_4^*}$$

$$+ \underset{(2.7)}{.16k_5^*} + \underset{(7.0)}{.2D} - \underset{(-.3)}{.009E} \qquad (4.3)$$

$R^2 = .4$

F-statistic = 11.7

$$w^* = \underset{(-1.7)}{-11.5} - \underset{(-3.7)}{.2k_1^*} - \underset{(-2.3)}{.001k_1^{*2}} - \underset{(-1.6)}{.17k_2^*} - \underset{(-.1)}{.00002k_2^{*2}}$$

$$+ \underset{(2.5)}{.23k_3^*} - \underset{(-1.9)}{.001k_3^{*2}} + \underset{(.17)}{.48k_4^*} - \underset{(-1.0)}{.004k_4^{*2}} - \underset{(-.2)}{.02k_5^*}$$

$$- \underset{(2.5)}{.005k_5^{*2}} - \underset{(-.9)}{.04D} + \underset{(6.9)}{.002D^2} + \underset{(2.4)}{.18E} - \underset{(2.4)}{.003E^2} \qquad (4.4)$$

$R^2 = .64$

F-statistic = 15.06

For all four equations, the null hypothesis (β=0) is rejected. This follows since the calculated F-statistics (17.96, 20.66, 11.7 and 15.06) are larger than the tabular F-values in each case using a confidence level α of .05. The tabular F-values are $F_{4,128,.05} = 2.44$ for equation (4.1); $F_{7,125,.05} = 2.08$ for equation (4.2); $F_{8,124,.05} = 2.02$ for equation (4.3); and $F_{15,117,.05} = 1.75$ for equation (4.4). Of course, the F-statistics alone do not give rise to a preference for one of the equations over any other. As is argued below, however, other considerations suggest that those equations relating to aggregated stocks (4.1 and 4.2) are preferable to those dealing with disaggregated stocks (4.3 and 4.4).

The question may arise as to the existence of multicollinearity, for example in equation (4.1), particularly because of the potential association between E and $\sum_{i=1}^{5} k_i^*$. However, an examination of the simple correlation coefficient shows that the absolute value of each coefficient is less than .11, suggesting that multicollinearity is not a serious problem. The similar correlation coefficients for this case are given below (where $\bar{k}$ is used to denote $\sum_{i=1}^{5} k_i^*$).

$r_{DE} = -.037$

$r_{E\bar{k}} = .1$

$r_{D\bar{k}} = .089.$

From (4.1) and (4.2), total capital stocks, relative distance to a metropolitan area, and percentage change in employment are seen to explain 30 to 50 percent of observed wage differentials (the R^2 values). Total capital stock (per capita) differentials and relative distance are significant in explaining these wage differentials in the linear case where weekly wage increases of \$.04 are implied for each dollar that per capita capital stocks in the base town exceed those in the boom community. The significant linear relationship between total per capita infrastructural capital and wage differentials is also manifested in the quadratic structure. The squared term is not statistically significant (t=.25 for the coefficient for $\{\Sigma k_i^*\}^2$), whereas the linear term is significant (t=-2.5; the tabular t value for a confidence level of α = .05 and 120 degrees of freedom is $t_{120,.05} = 1.66$).

In (4.3) and (4.4) the results of regressions are presented wherein wage differentials are attributed to per capita differentials in specific <u>types</u> of urban infrasturcture. In the linear regression (4.3), included variables explained some 40 percent of observed wage differentials (R^2 = .4). Wage differentials are seen to vary "significantly" with infrastructure differentials for education, public safety, and "all other." The negative sign on "all other" capital infrasturcture suggests that deterioration in the boom community's stocks relative to the base town is associated with <u>smaller</u> wage differentials. There is reason to believe, however, that this seemingly perverse result may reflect data problems to a greater extent than it reflects a conceptual incongruity.[1]

Looking to the quadratic regression (4.4), linear and squared terms are significant for education, water and sewage, and percent employment changes; only squared terms are significant for "all other" and distance. In contrast to the linear relation discussed above, the structure of the non-linear relation between "all other" and wage differentials is consistent with the basic proposition. Also, the impact of instability in labor markets (the E variable) in terms of explaining wage differentials is significant in the quadratic expression in contrast with the linear structure.

A number of anomalies are apparent in comparing equations (4.3) and (4.4) in addition to those discussed above. In terms of explaining wage differentials, facilities for public safety are statistically significant in the linear structure, not statistically significant in the quadratic expression. Facilities for water and sewage are not statistically significant in (4.3), statistically significant in (4.4).[2] Capital facilities for recreation are the only variables for which coefficients are not statistically significant in both tests.

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[1]In particular, the "all other" capital category is simply a catchall for investments other than those identified by k_1 through k_4; investment expenditures which could not be classified as to purpose, which include <u>all</u> investments from revenue-sharing funds, were placed in this category.

[2]A further counterintuitive result relates to the negative sign on the squared terms for education and water/sewage, which implies that wage differentials increase at a <u>decreasing</u> rate as capital differentials get increasingly large.

These analyses suggest the following tentative conclusions. The notion that wage differentials can be attributed to urban infrastructure differentials between boomtown communities and some base is to some extent statistically supported. If, then, the goal was to generate measures for social benefits as they relate to total investments in urban infrasturcture, leaving aside questions related to the optimal mix for types of infrastructure, the results of these analyses might serve as a surrogate measure for the community's subjective valuation of these benefits. Thus, investment planners would associate $.04 in weekly per capita social benefits to each dollar in which urban infrastructure differentials (relative to a base town) are reduced.

Attempts thus far to get at the optimal mix issue, i.e., to disaggregate total capital stocks into their various functional types and associate wage differentials to each type of urban infrastructure, are still at a very formative stage. Interestingly enough, these analyses consistently result in a statistically significant relationship between wage differentials and educational facilities, while statistically significant relationships between wage differentials and other capital-types are still somewhat questionable. This observation may suggest that individuals are particularly concerned with educational facilities, while all other types of urban infrasturcture are seen as a gestalt reflecting the general quality of the living environment in the boom community. This is strictly conjectural at this point in time, but may serve as a useful line of inquiry in future research on this problem.

In terms of capital for schools, however, results from equation (4.3) suggest that investment planners might associate $.17 in weekly per capita social benefits with each dollar by which differentials in school-capital, relative to the base town, are reduced.

CHAPTER V

CONCLUDING REMARKS AND SUGGESTIONS FOR FURTHER RESEARCH

5.A Introduction. As described in Chapter I, the intended contribution of this dissertation is essentially two-fold. First a conceptual argument is developed which suggests a methodology for indirectly measuring the subjective benefits which individuals attribute to urban infrastructure. The value of these measures is that they might be used by urban planners in boomtowns in their efforts to develop optimal investment strategies for the provision of urban infrastructure. Second, the hypotheses implied by this methodology were subjected to statistical analyses.

The relative weaknesses of available data notwithstanding, the results of the statistical analyses presented in the dissertation would seem to suggest that the proposed relationship between wage differentials and (total) per capita infrastructure differentials, as they relate to potentially useful measures of infrastructure benefits, has considerable promise. Given the relative poverty of the current state-of-the-arts in terms of an understanding of urban infrastructure-related benefits, the results presented here suggest that resources required to finance further efforts to generate and refine data, as well as to develop alternative hypotheses related to the basic proposition presented here, may well have high potential pay-offs.

In terms of establishing a statistically significant relationship between wage differentials and disaggregative urban infrastructure, the results of the author's analyses are much less satisfying. As implied by discussions in section D of Chapter III, the crudeness of available data might lead one to suspect the relative inclusiveness of the hypotheses related to disaggregated capital stocks. Clearly, a great deal of work in terms of refining data remains before the potential of the author's suggested methodology for dealing with benefits attributable to disaggregated capital stocks can be adequately assessed.

As with most exploratory efforts of this kind, the contribution of initial efforts may be more along the lines of identifying how one might better conduct the inquiry than in having developed conclusive results. That is, at the end of the study one would like to throw away the "results" and begin anew taking advantage of his knowledge and experience gained through the trial and error process followed during the initial efforts. The author certainly has this feeling regarding the results presented here.

However, the intelligence gained through exploratory efforts as it relates to how one might push on in terms of refining a suggested method may in itself be a worthwhile contribution. The author wishes, then, to present in some detail suggestions for further research which reflect his *ex-post* reflections on his treatment of concepts and data problems. To this end, in Sections 5.B and 5.C attention is focused on issues related to problems associated with the key variables in the basic proposition wage and capital measures, respectively. In Section 5.D the dissertation concludes with suggestions as to alternative statements of testable hypotheses related to the wage-infrastructure argument which include additional variables.

5.B Wage-related Issues. The major data problem concerning wages is that the major source for published data related to wages reports periodic earnings and employment by counties.[1] Three problems then arise. First, with wages defined as reported earnings divided by employment, potentially substantial biases may be introduced by such things as regional differences in overtime and part-time employment. Second, when the need is for "wage" data for towns, one is forced to use county data as surrogates for town wages. A major problem here is encountered when more than one boomtown exists in a county. Finally, wage data are not reported for sectors in a county when such data would violate state disclosure laws.[2]

One can improve wage data in cases where it is possible to obtain unpublished ES-202 reports prepared by the Employment Security agencies in each state. The author had limited success in obtaining data from this source (therefore, data presented in Chapter III were not associated with the names of towns). Disclosure laws, and thus the difficulty of obtaining access to the ES-202 reports, vary from state to state, and considerable time may be required to obtain the legal clearances required for access to these data.[3] Other than attempting to obtain such data by interviewing individual firms, however, the acquisition of such data is the only source for improving wage estimates known to the author, and, as

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[1]New Mexico Employment Security Committee, "New Mexico Covered Employment and Wages Quarterly" (Employment Security Commission) 1964-75.

[2]State disclosure laws prohibit publication of data which would provide information as to wage-employment figures associated with a particular firm. Thus, in counties with but one or two mining firms, for example, wages and employment for the mining sector would not be reported.

[3]The author's request has been pending now (August, 1976) for four months.

implied by the weaknesses of published data described above, is a prerequisite for further research concerning wage-infrastructure relationships.

There is also an interesting conceptual issue that relates to the use of wage differentials as surrogate measures for benefits attributable to urban infrastructure in the sense that such benefit measures might be used by investment planners to evaluate infrastructure. This issue concerns the question as to whether or not it is appropriate to use wage differentials (at the margin) for a particular occupation (in this study, mining or construction) as a measure of the entire town's subjective valuation of infrastructure.[1] As set out in Section D of Chapter III, the rationale for using mining or construction wages for examining wage-infrastructure trade-offs was that the wage received by the last (marginal) unit of labor in these sectors would most likely reflect subjective valuations related to the quality of life in the boomtown, ceteris paribus. But at issue here is the possible difference in such subjective valuations between, for example, relatively mobile construction workers with possibly short horizons in terms of living in the boomtown and pre-boom residents who, in many cases, tend to be older and less mobile. If β, the coefficient associated with infrastructure generated via statistical methods such as seen in equations (3.1)-(3.4), is taken to be a measure of the construction worker's marginal valuation of infrastructure stocks (per household) and H is the total number of

[1]The author is indebted to Professor Alan V. Kneese, University of New Mexico, for his comments on this subject, as well as on many of the other topics discussed below.

households in the boomtown, is $\beta \cdot H$ then the appropriate measure of marginal benefits attributable to an increment in investments?

On a priori grounds there is no reason to expect that, for example, permanent residents of the boomtown would place higher or lower values (costs) on deteriorations in the quality of services from urban infrastructure than would new arrivals to the boomtown. All that can be said at this time is that this consideration should be given considerable thought prior to data construction efforts in future research along lines suggested in this dissertation.

5.C Capital-related Issues. A particularly bothersome problem in terms of capital stocks is that of obtaining estimates of such stocks for small towns. Weaknesses implicit to the estimation-technique used in this study (the assumption that all towns have the same pre-boom (base town) per capita stocks) are obvious. The author's visits to a few small towns suggest, however, that few if any towns maintain records on assessed values of urban infrastructure, in which case one is left in a quandary as to how better estimates might be generated.

One approach to this problem might be to use the capitalization technique used to estimate base town stocks (Section D of Chapter III). Many towns do not have budget data for enough years to make this approach generally feasible, however. Further, given the "lumpy" and long-lived nature of many infrastructure items, the use of average annual investments as surrogates for depreciation may lead to serious biases in stock estimates.[1]

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[1]Thus, if one has town investment data for a water system which requires little or no maintenance expenditures over the 1965-74 period, but the major investment for the system was in 1964, capital stocks may

An alternative approach with which this author is currently experimenting is that of simply taking town inventories of infrastructure items for 1976, and estimating replacement costs. Stock estimates for earlier years are then estimated by subtracting town investment data for prior years from 1976 estimated stocks. An estimate for 1970 stocks, for example, is the 1976 stock less investments during the 1971-76 period.

A second capital-related problem concerns the differences in the qualitative nature of a given type of capital stocks across towns. Thus, in some towns the response to pressures on school facilities is to construct modular, frame, or other types of temporary buildings as opposed to more permanent (brick) facilities found in other towns. Town A with $5 million in school facilities may then have the same student:classroom ratio as Town B with $10 million in school facilities. How then does one interpret the _per capita investment_ differentials between the two towns?

In a similar vein, it is possible to substitute operating costs for capital expenditures. Some New Mexico towns pay fees to the State to have state police provide some level of patrolling services in lieu of establishing a local police force. Towns may lease portable buildings for the short-run provision of facilities such as schools. These problems, along with the "quality" problem described above, give rise to serious questions regarding the reliability, if not the usefulness, of cross-sectional data on capital stocks. Alternatives to attempts at careful use of these data, however, are not apparent to the author.

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be seriously underestimated. If the project was constructed in the 1965-74 period for a system with a 50-year life, capitalization of "depreciation expenditures" (the average 1965-74 investment level) may seriously overestimate stocks.

5.D Alternative Hypotheses. In retrospect, the author has become aware of a number of alternative hypotheses regarding or relating to the determinants of wage differentials which involve the inclusion of variables in addition to those used for the regressions (3.1)-(3.4) in Chapter III, all of which would be consistent with the basic proposition developed in Chapter II. The thesis is concluded with a brief discussion of a few of these variables, the inclusion of which might well enrich future inquiries concerning the nature of wage-infrastructure trade-offs.

First, a prime candidate for an included variable may well be some measure of private capital expenditures in the boom community. Certainly the results of Gilmore's survey suggest that such private capital-related things as shopping centers and facilities are of paramount concern to boomtown dwellers, not to mention such other things as the availability of housing.[1]

Second, the "distance" variable, D, may in fact reflect a wide range of such things as feelings of relative isolation, costs of acquiring medical care, access to air travel facilities, and other considerations related to convenience. Thus, efforts to (again) disaggregate the "distance" variable may have high potential pay-offs in terms of improving the estimates of social capital-related changes in wage differentials.

Third, and finally, one may wish to experiment with the hypothesis that wage differentials are explained by expected differentials in capital infrastructure. Of course, there are a number of ways by which one may choose to "measure" expected capital differentials. The author is currently experimenting with this hypothesis wherein he assumes that

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[1]Gilmore (1976), op.cit.

pre-boom levels of total capital stocks obtained over the four-to-eight year construction period, combined with rapidly increasing population, result in the rapid decline of _per capita_ capital stocks. The assumption that no net investment takes place over the construction period--as a method of imposing one measure of expected infrastructural differentials--is consistent with the "front-end" problem faced by many boomtown communities. This is simply to say, however, that alternative hypotheses related to the wage differential argument may profitably serve as lines of future research inquiry.

APPENDIX

TABLE A

Identification of Boomtowns and Years for which Data are Compiled for Each Town

NEW MEXICO

Town	County	Year
Albuquerque	Bernalillo	1967 1968 1969 1970 1971 1972 1973
Clovis	Curry	1970 1971 1972 1973
Farmington	San Juan	1970 1971 1972 1973 1974
Gallup	McKinley	1966 1967 1968 1969 1970 1971 1972 1973 1974
Lovington	Lea	1970 1971 1972 1973 1974
Ruidoso	Lincoln	1970 1971 1972 1973 1974

TABLE A, continued

Town	County	Year
Tucumcari	Quay	1968
		1969
		1970
		1971
		1972
		1973
		1974
Alamogordo	Otero	1970
		1971
		1972
		1973
		1974
Taos	Taos	1969
		1970
		1971
		1972
		1973
		1974
Aztec	San Juan	1970
		1971
		1972
		1973
		1974
Clayton	Union	1971
		1972
		1973
Grants	Valencia	1966
		1967
		1968
		1969
		1970
		1971
		1972
		1973
		1974
Bloomfield	San Juan	1970
		1971
		1972
		1973
		1974
Loving	Eddy	1971
		1972
		1973
		1974

TABLE A, continued

Town	County	Year
Milan	Valencia	1970
		1971
		1972
		1973
		1974
Questa	Taos	1967
		1968
		1969
		1970
		1971
		1972
		1973
		1974
Springer	Colfax	1970
		1971
		1972
		1973
		1974
Hobbs	Lea	1970
		1971
		1972
		1973
		1974
Las Cruces	Dona Ana	1969
		1970
		1971
		1972
		1973
		1974
	COLORADO	
Loveland	Larimer	1971
		1972
		1973
Grand Junction	Mesa	1971
		1972
		1973
Fort Collins	Larimer	1972
		1973
Manitou Springs	El Paso	1971
		1972
		1973

TABLE A, continued

Town	County	Year
Craig	Moffat	1971
		1972
		1973
Glenwood Springs	Garfield	1971
		1972
		1973
Steamboat Springs	Routt	1971
		1972
		1973
Mesker	Moffat	1972
		1973
Fruita	Mesa	1971
		1972
		1973

TABLE B

Observations for w*, k*, D* and E

Used for Regressions

Class A Towns

Town	Obs.	w*	k_1*	k_2*	k_3*	k_4*	k_5*	D*	E
1A	1	20	-25	18	-11	-6	-26	115	55
	2	20	-29	18	-25	-9	-39	115	180
	3	29	-72	42	-41	-17	-75	115	103
	4	38	-81	53	-47	-13	-92	115	107
	5	52	-91	59	-48	0	-100	115	126
2A	1	62	15	-9	-8	-3	-13	203	102
	2	97	4	-25	-20	-8	-33	203	137
	3	97	-10	-39	-15	-12	-53	203	117
3A	1	4	4	-7	-11	-4	-22	120	119
	2	-6	35	3	-3	2	-10	120	119
	3	-23	74	16	10	9	7	120	101
	4	-2	15	-4	-3	-2	-8	120	86
4A	1	40	-18	-18	-15	-5	-18	165	106
	2	62	-42	-44	-28	-10	-40	165	104
5A	1	16	-64	-37	-30	-12	-56	83	69
	2	20	-69	-34	-33	-14	-64	83	4
	3	24	-73	-35	-36	-15	-70	83	146
	4	6	-45	-20	-27	-12	-56	83	130
	5	3	-28	-17	-23	-12	-49	83	109
6A	1	25	2	-24	-21	-8	-40	80	116
	2	26	-8	-46	-38	-15	-73	80	144
	3	28	-14	-60	-49	-20	-95	80	207
	4	31	-85	-94	-76	-31	-147	80	113
	5	42	-44	-86	-69	-29	-134	80	115
	6	53	-69	-109	-88	-36	-168	80	80
	7	31	-77	-122	-100	-41	-188	80	104
	8	61	-28	-126	-103	-43	-194	80	114
7A	1	0	11	1	0	0	1	62	42
	2	-2	-6	-7	-11	-7	21	62	113
	3	0	-24	-12	-20	-12	36	62	88
	4	1	-31	-13	-24	-15	43	62	134
	5	3	-37	-14	-26	-17	41	62	54
8A	1	36	-10	-2	2	-2	-6	129	105
	2	30	-17	-4	6	-4	-10	129	104
	3	15	-34	-10	0	-7	-15	129	114
	4	8	-25	-17	-6	76	-21	129	73
	5	32	-3	-7	-8	-5	-17	129	119
	6	61	-12	-15	-16	-10	-28	129	101

TABLE B, continued

Town	Obs.	w*	k_1*	k_2*	k_3*	k_4*	k_5*	D*	E
9A	1	48	-11	-13	-6	-4	8	101	138
	2	45	-11	-26	-16	-8	-10	101	215
	3	27	-22	-38	-26	-12	-28	101	127
Class B Towns									
1B	1	20	-7	0	0	-2	-4	110	55
	2	20	-5	-1	2	-2	-4	110	180
	3	29	-34	-8	-4	-8	-23	110	103
	4	38	-82	-20	-15	-17	-49	110	107
	5	52	-100	-26	-19	-21	-45	110	126
2B	1	-8	27	12	0	-1	30	31	8
	2	-10	65	17	11	0	40	31	567
	3	-14	16	14	12	15	19	31	600
3B	1	60	-26	-11	-12	-7	-24	102	95
	2	58	-40	-21	-24	-14	-29	102	140
	3	62	-66	-30	-24	-22	-48	102	132
4B	1	53	-13	-6	-7	-4	-11	149	132
	2	40	-34	-12	-14	-8	-24	149	106
	3	62	-36	-18	-19	-12	-37	149	104
5B	1	25	-29	-35	-29	-11	-50	83	118
	2	50	-63	-56	-51	-19	-88	83	167
	3	46	-76	-66	-62	-23	-107	83	102
	4	40	-77	-68	-68	-25	-117	83	114
	5	36	-96	-76	-73	-29	-135	83	105
	6	30	-123	-86	-85	-33	-155	83	104
	7	15	-99	-81	-83	-34	-148	83	114
	8	8	-96	-72	-82	-34	-147	83	107
	9	28	-110	-76	-89	-36	-156	83	133
6B	1	-11	6	-1	0	-1	-3	-36	84
	2	-13	34	5	7	1	9	-36	120
	3	-9	73	19	25	11	33	-36	84
	4	-1	18	4	13	1	1	-36	106
	5	12	4	5	12	0	13	-36	140
7B	1	52	-7	-4	-5	31	-1	-61	128
	2	66	-12	-8	-10	28	200	-61	130
	3	61	-20	-12	-14	30	195	-61	107
8B	1	30	-43	-10	-10	-8	-25	46	69
	2	38	-78	-16	-14	-14	-39	46	141
	3	34	-157	-38	-38	-28	-85	46	46
	4	33	-207	-55	-57	-39	-120	46	130
	5	35	-230	-60	-59	-44	-129	46	109

TABLE B, continued

Town	Obs.	w*	k_1*	k_2*	k_3*	k_4*	k_5*	D*	E
9B	1	-30	30	7	23	5	17	22	62
	2	-17	64	9	25	6	21	22	135
	3	10	73	0	20	2	8	22	103
	4	0	73	1	21	2	8	22	61
	5	2	66	-1	23	5	6	22	244
	6	5	91	3	62	8	13	22	75
	7	10	116	2	56	8	87	22	173
Class C Towns									
1C	1	8	-21	-6	-6	-4	-14	20	81
	2	12	-38	-12	-12	-8	-29	20	67
	3	9	6	1	4	2	0	20	6
	4	23	-9	-8	-10	-7	-26	20	136
	5	-4	-5	-6	-8	-6	-24	20	96
2C	1	11	-11	-4	-5	-3	-9	-66	92
	2	12	-36	-12	-14	-10	-28	-66	102
	3	11	-42	-16	-18	-14	-37	-66	107
	4	16	-66	-23	-27	-20	-53	-66	108
	5	9	-95	-32	-39	-25	-75	-66	123
	6	14	-123	-40	-50	-32	-96	-66	128
	7	14	-232	-42	-54	-34	-103	-66	102
3C	1	14	-25	-8	-10	-5	-19	24	87
	2	14	-51	-16	-21	-11	-39	24	142
	3	12	-47	-15	-21	-10	-34	24	111
	4	7	-42	-15	-22	-10	-33	24	124
4C	1	20	-8	-3	18	-3	-8	115	55
	2	20	-17	-5	34	-6	-15	115	180
	3	29	-46	-13	40	-12	-37	115	103
	4	38	-75	-16	45	-19	-53	115	107
	5	52	-82	-18	67	-20	-53	115	126
5C	1	56	-44	-14	-7	-9	-31	-4	130
	2	53	-60	-22	-8	-18	-60	4	4
6C	1	33	-22	-7	27	-3	2	72	100
	2	32	-46	-13	51	-7	-2	72	125
	3	29	-76	-14	100	-14	-22	72	118
	4	26	-107	-24	148	-19	-32	72	108
	5	31	-122	-27	201	-22	-34	72	129
	6	41	-135	-30	199	-24	-34	72	113
	7	46	-141	-35	20	-26	-43	72	76
	8	37	-120	-35	217	-26	-43	72	140
	9	37	-117	-36	219	-29	-48	72	110
7C	1	62	1	-6	-3	-5	-16	191	102
	2	97	-8	-12	-5	-10	-25	191	137
	3	97	-20	-18	0	-15	-40	191	117

TABLE B, continued

Town	Obs.	w*	k_1*	k_2*	k_3*	k_4*	k_5*	D*	E
8C	1	-11	17	6	7	5	13	43	84
	2	-13	17	6	9	5	14	43	120
	3	-9	32	11	16	10	26	43	84
	4	-1	24	6	8	7	16	43	106
	5	12	7	1	1	3	10	43	140
9C	1	15	-19	-6	-8	-5	-13	-22	79
	2	5	-28	-8	-11	-7	-19	-22	136
	3	3	-34	-10	-14	-9	-24	-22	125
	4	-2	-29	-9	-11	-8	-22	-22	105
	5	-7	-28	-10	-12	-9	-24	-22	132
10C	1	35	-50	-9	-24	-15	-46	-14	133
	2	56	-90	-36	-44	-27	-84	-14	130
	3	53	-130	-46	-32	-37	-115	-14	114

BIBLIOGRAPHY

Ackoff, R.L. "Toward Quantitative Evaluation of Urban Services." Public Expenditures Decisions in the Urban Economy. Edited by H.G. Schallen. Baltimore: Johns Hopkins University Press, 1963.

Allen, Edward H. "Financing Infrastructure in Energy Production Areas." Paper presented at the Seminar on Financing Infrastructure in Energy Production Areas, sponsored by the Rocky Mountain Institute for Policy Research, Snowbird, Utah, August 21-22, 1975.

Baumol, William J. "Urban Services: Interactions of Public and Private Decisions." Municipal Needs, Services and Financing, Reading on Municipal Expenditures. Edited by Patrick W. Beaton. New Jersey: Center for Urban Research, Rutgers University, 1974.

Birdsall, William C. "A Study of the Demand for Public Goods." Essays in Fiscal Federalism. Edited by Richard A. Musgrave. Washington, D.C.: The Brookings Institution, 1965.

Bradford, D.F. "Benefit Cost Analysis and Demand Curves for Public Goods." Kykols, 23 (1970), 775-91.

Brookshire, David; Ives, Berry; and Schulze, William. "The Evaluation of Aesthetic Preferences." Southwest Regional Project Working Paper Series, Department of Economics, University of New Mexico, Albuquerque (no date).

Burt, O.R., and Cummings, R.G. "Production and Investment in Natural Resource Industries." American Economic Review, IX(4) (December 1970), 576-90.

Coleman, J., et al. "Equality of Education Opportunities." U.S. Office of Education. Washington, D.C.: U.S. Government Printing Office, 1966.

Environmental Protection Agency. "Socio-economic Input and Federal Assistance in Energy Development Impacted Communities in Federal Region VIII." Committee on Socio-economic Impacts, Mountain Plains Federal Region Council, Region VII, Denver, July 1975.

Federation of Rocky Mountain States. "Energy Development in the Rocky Mountain Region: Goals and Concerns." Denver, July 1975.

Frye, Richard. "Inter-basin Transfers of Groundwater for Municipal Supply: A Case Study in Rhode Island." Unpublished Ph.D. dissertation, University of Rhode Island, 1975.

Gilmore, John S., and Duff, Mary K. "The Evolving Political Economy of Pitkin County: Growth Management by Consensus in a Boom Community." University of Denver Research Institute, Denver, March 1974.

__________. "The Sweetwater County Boom: A Challenge to Growth Management." Unpublished working paper, University of Denver Research Institute, July 1974.

Gilmore, John S. "Boomtowns May Hinder Energy Resource Development." Science, 191 (February 13, 1976), 535-40.

Grigalunas, Thomas A. Offshore Petroleum and New England. Marine Technical Report No. 37, University of Rhode Island, 1975.

Guthrie, J.W.; Kliendoffer, C.; Levie, H.; and Stout, R. Schools and Inequality. Cambridge: MIT Press, 1971.

Head, John G. Public Goods and Public Welfare. Durham, N.C.: Duke University Press, 1974.

Henderson, James M. "Local Government Expenditures: A Social Welfare Analysis." The Review of Economics and Statistics, 54.

Herfindal, Orris C., and Kneese, Allen V. Economic Theory of Natural Resources. Ohio: Charles E. Merrill Publishing Co., 1974.

Hoch, Irving. "Urban Scale and Environmental Quality." Population, Resources and the Environment. Edited by R. Ridker. Commission on Population Growth and the American Future, Research Reports Vol. III, Washington, 1972.

Howe, C.W. Benefit Cost Analysis for Water System Planning. American Geophysical Union, 1971.

Ives, Berry, and Eastman, Clyde. "Impact of Mining Development on an Isolated Rural Community: The Case of Cuba, New Mexico." New Mexico Agricultural Experiment Station Research Report #301, Las Cruces, August 1975.

Ives, Berry, and Schulze, William. "Boomtown Impacts of Energy Development in the West; the Case of Page, Arizona." Lake Powell Research Bulletin (forthcoming).

Kee, W.S. "Industrial Development and Its Impact on Local Finance." Quarterly Review of Economics and Business, 8(3) (1968), 19-24.

Leholm, Arlen G.; Leistritz, F. Larry; and Hertsgaard, Thor A. "Fiscal Impact of a New Industry in a Rural Area: A Coal Gasification Plant in Western North Dakota." Paper presented at the Seventh Annual Meeting, Mid-Continent Section, Regional Service Assn., Duluth, Minn., June 13-14, 1975.

Lichtenstein, Grace. "Town's Boom Halted by a Strip Mine Ban." The New York Times, November 20, 1975.

Loesenstein, L.K. "The Impact of New Industries on the Fiscal Revenues and Expenditures of Suburban Communities." National Tax Journal VI(2) (1963), 113-29.

Maler, Karl-Goran. "Environmental Economics: A Theoretical Inquiry." Resources for the Future, Inc. Baltimore: Johns Hopkins Press, 1974.

Markley, O.W., and Bagley, Marilyn D. "Minimum Standards for Quality of Life." U.S. Environmental Protection Agency, Washington, 1975.

Morgan, William E, and Hackbart, Merlin M. "An Analysis of State and Local Industrial Tax Exemption Programs." So. Econ. Journal (October 1974), 200-05.

Mullenkopf, William, and Melville, Donald. "A Study of Secondary School Characteristics as Translated into Test Scores." Educational Testing Service, Research Bulletin #56-6, Princeton, 1956.

Musgrave, Richard A. The Theory of Public Finance. New York: McGraw-Hill Book Company, 1959.

__________. "The Voluntary Exchange Theory of Public Economy." Quarterly Journal of Economics, 53 (February 1939), 213-17.

Neenan, William B. Political Economy of Urban Areas. Chicago: Markham Publishing Co., 1972.

New Mexico Employment Security Commission. "New Mexico Covered Employment and Wages Quarterly." Employment Security Commission, New Mexico, 1964-75.

New Mexico State Board of Education. "Public School Finance." Department of Finance and Administration, 1964-75.

Ohls, J.C., and Wales, T.J. "Supply and Demand for State and Local Services." Review of Economics and Statistics, 50(3) (November 1972), 424-30.

Rodriguez, D. et al. vs. San Antonio Independent School Districts, et al. U.S. District Court, Western Districts of Texas, 411 U.S. 1, March 1975.

Samuelson, P.A. "The Pure Theory of Public Expenditure." Review of Economics and Statistics, 36(4) (November 1954), 382-89.

Schaller, Howard G., ed. "Public Expenditure Decisions in the Urban Community." Resources for the Future, Inc., Washington, 1963.

Summers, Anita, and Wolfe, Barbara. "Some School Resources Help Some Students to Learn, But Which?" Tax Review, XXXVI (September 1975), 37-40.

Tamplyn, E. Inequality: A Portrait of Rural America. Washington, D.C.: Rural Education Association, 1973.

Thomas, Alan J. "Efficiency in Education: A Study of the Relationship between Selected Inputs and Mean Test Scores in a Sample of Senior High Schools." Unpublished Ph.D. dissertation, Stanford University, Palo Alto, 1968.

Tiebout, C.M. "Pure Theory of Local Expenditures." Municipal Needs, Services and Financing Reading on Municipal Expenditures. Edited by Patrick W. Beaton. New Jersey: Rutgers University, Center for Urban Research, 1974.

United States Department of Commerce, Bureau of the Census, Social and Economic Statistics Administration. "Federal-State Cooperative Program for Population Estimates, Series P-26, New Mexico and Colorado." Washington, D.C., June 1975.

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