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ECONOMIC IMPACTS ASSOCIATED WITH PURE TAXABLE CAPACITY CHANGES*

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I. INTRODUCTION

Fiscal impact studies have traditionally been concerned with the balance between new public service demands and new tax revenues that accompanies local economic development.[1] Typically, estimates of tax base changes and public service expenditures are constructed and analyzed to determine if new development will cause marginal tax burdens to increase or decrease. This approach is preferable to simply measuring aggregate changes in fiscal capacity, the overall ability of a community to raise tax revenues,[2] since they highlight the fact that new development, while perhaps benefiting the local private sector, can place additional burdens on the local public sector.

In this paper, an attempt is made to broaden the purview of fiscal impact analysis to include impacts on the local private sector that may stem from local public sector changes. More specifically, attention is focused on the limiting case, in which new private sector development yields positive changes in fiscal capacity, but does not increase public service demands or interact with the local private sector. This phenomenon is termed a "pure" change in fiscal capacity, or, stated differently, pure tax revenue importation.

Interest in this issue stems from an analysis of the local impacts of constructing and operating nuclear power stations.[3] Nuclear power stations, like other electrical generating facilities, are characterized by large capital-labor ratios, implying that the impact of siting would be to increase local taxable capacity, via the property tax base, to a greater extent than local private sector activity, via new hirings. Moreover, a small labor force implies a modest change in the demand for local public services, and facilities of this nature by themselves demand few, if any, public services.[4] A nuclear power station, however, may be distinguished from other electrical generating

facilities through siting regulations that require locating in a low population density area, a fact which ensures the influence on the community will be substantial.[5] Taken as a whole, these characteristics approximate the pure fiscal capacity change described above.

The question of how and to what degree feedback effects from local public to local private sector may take place is described below in four segments.

In the first, the local decision-making process that determines the aggregate mix of public and private goods is examined through indifference curve analysis. Here it is concluded that local communities may increase, decrease, or hold constant their level of tax effort, depending on the "price" elasticity of demand for local public services, where prices are interpreted as the ratio between imported taxable capacity and total local taxable capacity.

In the next step, a simple macro model of a local community is developed to identify the parameters which may shape the ultimate size of the local impact. Here, it is emphasized that government and consumer demand "leakages" that result from purchasing goods and services outside community boundaries will truncate local multiplier effects set up by the increase in imported taxable capacity.

The third portion of the paper examines data collected for two communities in which power reactor sitings significantly modified local taxable capacity. It is concluded that local economic stimulation occurred through both private and public sectors, even though substantial tax rate decreases were evident. A corollary is that had the analysis focused solely on jobs contributed to the community by the power stations, the major source of local impacts to the community would have been overlooked. A final section concludes the paper.

II. COMMUNITY RESPONSE TO PURE TAXABLE CAPACITY INCREASES

From the community's point of view, the importing of tax bases appears much like an open-ended matching grant.[6] For every dollar the community chooses to raise through taxation, it also receives a proportional amount through importation, with the matching ratio given by the ratio of imported taxable capacity to local taxable capacity. For this reason, public services can become less expensive, relative to private services, when this ratio increases. Subsequently, there is an incentive to purchase an increased quantity of public goods.

This process can be illustrated through Figs. 1 and 2. Figure 1 can be interpreted as depicting a closed local economy in which neither the public nor the private sector imports or exports. Private goods, which can alternatively be interpreted as private income or taxable capacity, are shown on the vertical axis, and public goods are shown on the horizontal axis. The line PrPu defines a trade-off function showing the set of maximum obtainable combinations of public and private goods.[7] If we assume the existence of aggregable preferences for private and public goods which are operationalized through a local government decision structure, we can define a series of indifference surfaces which together with the transformation function can generate an "optimal" combination of public and private goods.[8] In this example, indifference curve II becomes tangent with PrPu at a point yielding Pr_1 private goods and Pu_1 public goods. Because public goods must be financed by levying a tax change on private activity, we can calculate a level of tax effort or "tax rate" by the ratio $Pr-Pr_1/Pr$. This, in effect, measures the quantity of private goods that must be sacrificed to obtain Pu_1 public goods, relative to the total quantity of private goods obtainable.

FIGURE 1

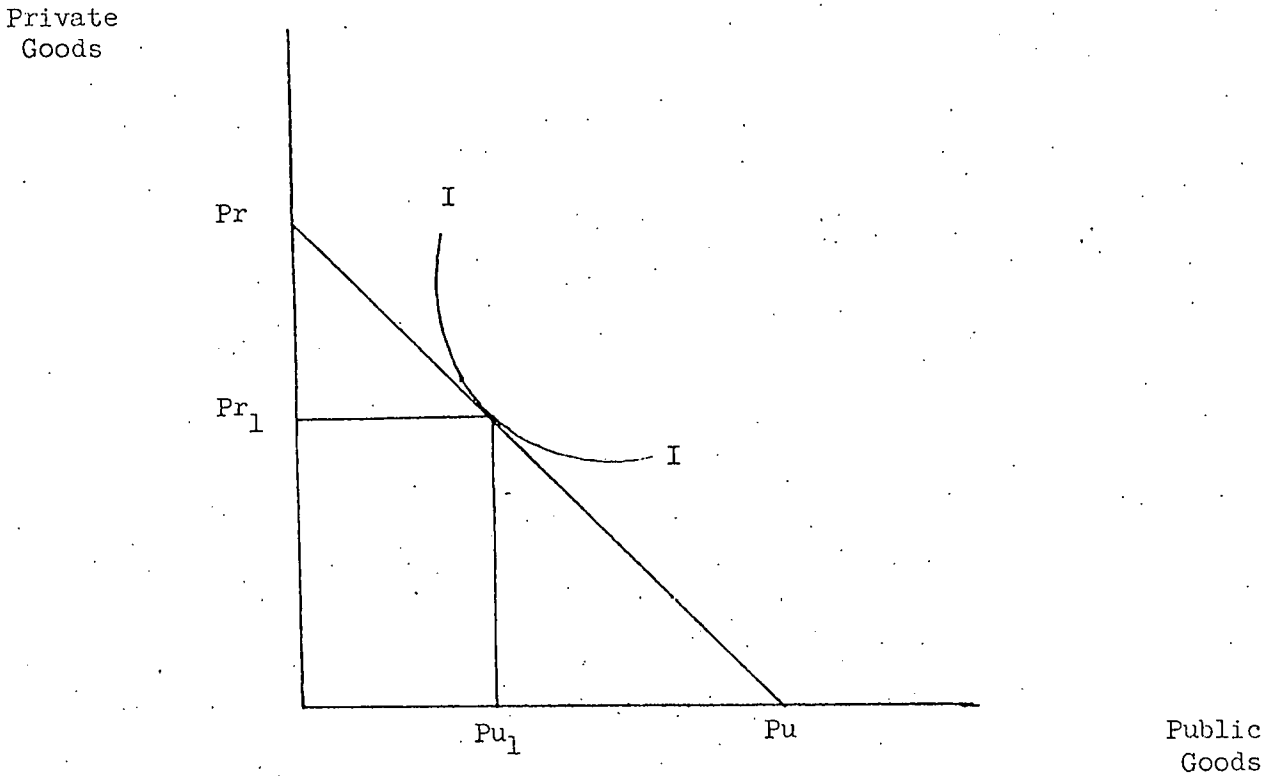
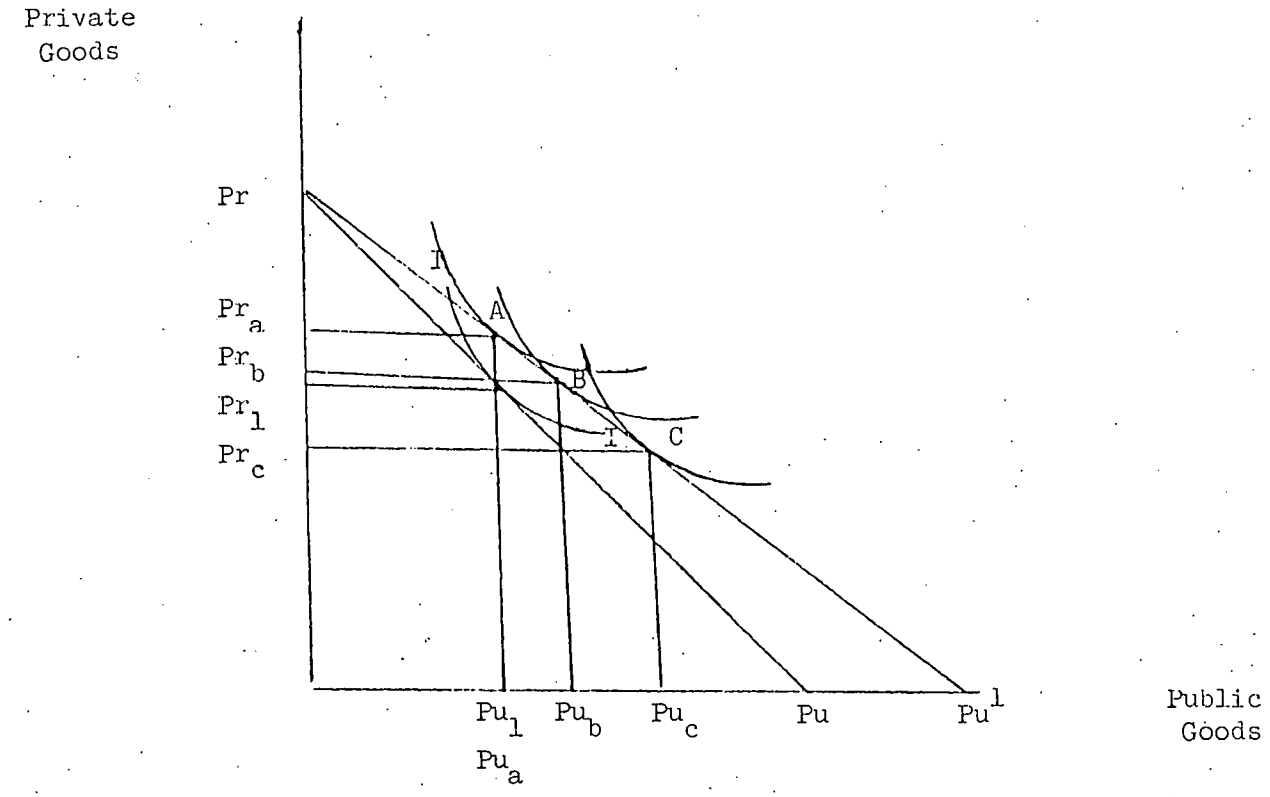


FIGURE 2



Pure increases in taxable capacity can be studied by extending a ray from Pr which falls to the right of Pu. This is shown in Fig. 2 as PrPu'. In this instance, the maximum obtainable level of private goods remains constant, since the level of local economic activity was not modified. However, given a positive level of tax effort, all attainable combinations of private and public goods exceed those possible prior to the taxable capacity increase. This implies that, within limits, the community enjoys the advantage of consuming the increase through either the public or private sectors (i.e., through increased disposable income) despite the fact that only the public sector was directly impacted.[9]

Points A, B, and C show three possible new equilibria, illustrating alternative community preferences which give rise to different price elasticities of public goods. Point B corresponds to an adjustment under unitary price elasticity conditions.[10] Point A is an inelastic response in which the community chose to leave public goods consumption constant and take its increase in real income in private goods, i.e., by increasing local disposable income through a tax rate decrease. In fact, this point illustrates a zero elasticity case which approaches the classic "Giffon Goods" example and would occur only if public goods are viewed as inferior to private goods, an unlikely response. Point C shows an elastic response in which the tax rate actually increased, leaving the community with a smaller quantity of private goods than prior to the capacity increase.

What this analysis suggests is that a range of alternatives are available to communities when faced with an increase in pure taxable capacity—a range that includes consumption of additional private goods as well as public goods. The key behavioral parameter in this analysis is the price elasticity of demand for public goods.

III. LOCAL INCOME DETERMINATION: THE ROLE OF IMPORTED TAXABLE CAPACITY

Once a community makes a decision as to a tax rate following a pure taxable capacity change, the degree to which its impact will affect the local economy is dependent on a number of additional behavioral parameters. In the previous section, a "closed" local economy was examined for the purpose of analyzing price-related behavior. In this section the impact is examined in both the context of a closed economy and with the relaxed assumption of an open economy. To conduct this analysis, it is necessary to develop a model of the local economy that considers both private and public sector components. For simplicity, it is assumed that local activity can be directly and linearly transformed into government revenues and by implication into government expenditures. While it would be possible to specify a system that would include several categories of fiscal capacity relative to local activity or imported activity levels, it is felt the current specification retains the essence of the issue at hand.

The model to be examined can be described through the following nine equations:

$$Y_L = C_L + G_L + I_L, \tag{1}$$

$$C_L = A_0 + b_L Y_{DL};\ 0 \leq b_L < 1, \tag{2}$$

$$Y_{DL} = \alpha Y_L;\ 0 \leq \alpha \leq 1, \tag{3}$$

$$b_L = A_1 A_2;\ 0 < A_1 < 1;\ 0 \leq A_2 \leq 1, \tag{4}$$

$$G = R_L + R_I, \tag{5}$$

$$R_L = (1 - \alpha) Y_L, \tag{6}$$

$$R_I = (1 - \alpha) X, \tag{7}$$

$$G_L = \beta G;\ 0 \leq \beta \leq 1, \tag{8}$$

$$I_L = I_0. \tag{9}$$

Equation (1) is the familiar equilibrium condition which states that local income (Y_L) is the sum of local consumption (C_L), local government expenditures (G_L), and local investment (I_L). Local consumption is the sum of local autonomous expenditure (A_0) plus the product of local disposable income (Y_{DL}) and the marginal propensity to consume locally (b_L). Local disposable income is a constant fraction of local income, where $(1 - \alpha)$ is equal to the local tax rate. The marginal propensity to consume locally can be decomposed into the marginal propensity to consume (A_1) and the share of marginal consumption that is consumed locally (A_2). Government expenditures can be defined as the sum of local revenue (R_L) and imported revenue (R_I), and a common tax rate $(1 - \alpha)$ is levied on both local fiscal capacity (defined as local income) and imported fiscal capacity (X). Since government may spend either within or without the community, a parameter (β) is used to define government's marginal (and average) local propensity to consume.[11] Finally, local investment is assumed to be autonomous. The equilibrium level of local income defined by this system is shown in Eq. (10).

$$Y_L = \frac{A_0 + I_L + \beta(1 - \alpha)X}{1 - A_1A_2\alpha - \beta(1 - \alpha)} \qquad (10)$$

With this system, we can discuss six cases describing local economies, the first two of which are admittedly trivial, but are included for completeness.

Case 1: Zero Local Government-Zero Leakages

For this case, β and X are set to zero, and α and A_2 are set to unity. This is the simplest depiction of a local economy that can be generated with this system, and local economic growth can occur only through changes in A_0, I_L, or A_1. With A_1 held constant, the multiplier for changes in autonomous local expenditure can be calculated as $[1/1 - A_1]$.

Case 2: Zero Local Government-Positive Leakages

For this case, A_2 is allowed to take values ranging from greater than zero and less than unity. The same conditions for Case 1 hold, and the local multiplier becomes $[1/1 - A_1A_2]$, with the result that for any level or change in level of autonomous local expenditure, local equilibrium will be correspondingly lower.

Case 3: Positive Local Government-Zero Leakages

In this case, Case 1 is modified by permitting α to assume positive values less than unity. Local economic activity remains driven by local autonomous expenditure, but government interacts with private consuming behavior to determine equilibrium levels of local activity and multiplier effects. For changes in autonomous spending the multiplier is given by $[1/\alpha(1 - A_1)]$. This value can be interpreted as follows: The larger the share of government activity, the smaller is the domestic leakage due to local savings, and hence, the larger is the multiplier. Thus, like the national economy, the local economy can benefit from direct stimulus on the part of government, and in general, the larger the role of government in the closed local economy, the larger will be the multiplier.

Case 4: Positive Local Government-Positive Leakages

This model corresponds most directly with the probable condition that would exist in a locality prior to the importation of fiscal capacity. Case 3 is modified to permit A_2 and β to assume positive values less than unity, and the multiplier is correspondingly altered to obtain

$$\text{Multiplier} = \frac{1}{1 - A_1A_2\alpha - \beta(1 - \alpha)} \qquad (11)$$

In this case, β may become a policy variable, since localities can, within limits, make choices as to purchasing locally produced goods, or requiring its

employees to live within community boundaries. However, the size of the multiplier also is indeterminant, since its size will vary according to the relative propensities of government and consumers to purchase local products. The relative size of the multiplier may be examined by evaluating the expression $[-A_1A_2\alpha - \beta(1 - \alpha)]$. When A_2 and β are equal, this expression can be made equal to that obtained for Case 3 with a proportionality factor multiplied times the expression to account for leakages, i.e., $Z\alpha(1 - A_1)$, where $A_2 = \beta$. When A_1A_2 is equal to β, the local economy will be stimulated equally by any tax rate, and when A_1A_2 is greater than or less than β, an increased tax rate will depress or stimulate the local economy, respectively.

Case 5: Positive Local Government-Zero Leakages-Fiscal Capacity Importation

This case corresponds to pure fiscal capacity impacts discussed in the preceding section and may be obtained by modifying Case 3 to include a positive value for X. Note that in this case a new source of autonomous expenditure is added to A_0 and I_0 yielding the expression

$$\bar{Y}_L = \frac{A_0 + I_L + (1 - \alpha)X}{\alpha(1 - A_1)}, \tag{12}$$

which when differentiated with respect to X to obtain the pure fiscal impact multiplier becomes

$$\text{Multiplier} = \frac{1 - \alpha}{\alpha(1 - A_1)}. \tag{13}$$

This ratio is positive for all feasible values of α and A_1. It can be shown that for all feasible values of A_1 the multiplier will increase as the tax rate increases. Thus, when there are no leakages in the local economy, it follows that not only do pure increases in taxable capacity stimulate the local economy, but the degree of stimulation is directly related to the local tax rate.

Case 6: Positive Local Government-Positive Leakages-Fiscal Capacity Importation

This final case is the most general that can be studied using the system outlined above. It is obtained by combining Cases 4 and 5 and yields the following equilibrium level of income:

$$\bar{Y}_L = \frac{A_0 + I_L\beta(1 - \alpha)X}{1 - A_1A_2^{\alpha} - \beta(1 - \alpha)} . \qquad (14)$$

Note that the exogeneous determinant of income (shown by the numerator) is reduced by the parameter β, the propensity of government to consume locally. Thus, while spending power is imported by an amount equal to the tax rate times the imported fiscal capacity, some share of this is exported due to government spending leakages. The multiplier for changes in fiscal capacity is shown in Eq. (15)

$$\text{Multiplier} = \frac{\beta(1 - \alpha)}{1 - A_1A_2^{\alpha} - \beta(1 - \alpha)} . \qquad (15)$$

Because of parameter restrictions, the numerator for this expression is less than unity. With this exception, the conclusions drawn for Case 4 with regard to Eq. (11) hold.

IV. EMPIRICAL EVIDENCE

The siting of the Pilgrim power station in Plymouth, Massachusetts, and the Millstone station in Waterford, Connecticut, provide a useful example for examining the concepts just discussed. Although the full range of parameters required in the previous two sections are not available and cannot be estimated with currently available data, examining the evidence at hand supports the usefulness of the concept of pure fiscal capacity changes.

Plymouth and Waterford are New England towns located on the coastlines south of Boston and north of New London, Connecticut, respectively. The 1970

census showed Plymouth with a population of 18,000 and Waterford with a population of 17,000.[12] Through 1975, Waterford gained approximately 1000 residents, while Plymouth experienced more rapid growth gaining some 7000 persons over this same period.[13] Property taxes provided 70% of local general revenues in Waterford in 1967 and 68% in 1972, while in Plymouth the respective figures were 52% and 73%.[14] Most additional revenues came from federal and state aid. In this regard, each town showed a share of locally raised revenues from property taxes and a change in this share similar to that found for all towns in their respective states. Nonetheless, they relied on property taxes to raise local revenues somewhat more heavily than the national average.[15]

The siting of the Millstone and the Pilgrim nuclear power stations occurred at roughly the same time, with construction beginning in about 1968 in each case. That these sitings significantly increased local fiscal capacity can be seen in Table 1. In Waterford, the Millstone station contributed $5.6 million to the property tax base in 1968, and an increasing amount over time as construction was completed, until 1974 when the station's contribution to the property tax base stood at 59%. A similar experience is evident in Plymouth, where in 1974 the Pilgrim station accounted for 46% of total assessments.

Because most general revenues in these towns come from the property tax (the bulk of remaining revenues being intergovernmentally transferred), it is possible to interpret these shifts in the composition of assessed value as the "price" changes between private and public goods discussed in Section II. Thus, for Waterford in 1974, the price of public goods relative to private goods had decreased by 59%. Stated differently, for each $.41 locally, $.59 was imported, due to the change in fiscal capacity that accompanied the siting of the Millstone station.

Table 1. Impact of Millstone and Pilgrim stations on assessed values in Waterford, Connecticut, and Plymouth, Massachusetts (in thousands of dollars)

	Waterford, Connecticut				Plymouth, Massachusetts			
Year*	Total value	Plant value	Plant proportion of total value	Nonplant value	Total value	Plant value	Plant proportion of total value	Nonplant value
1966	$ 66,053	—	—	$66,053	$ 43,451	—	—	$43,451
1967	66,462	—	—	66,462	45,827	—	—	45,827
1968	72,744	$ 5,643	0.08	67,101	47,629	$ 132	—	47,497
1969	90,334	20,867	0.21	67,467	51,515	1,456	0.03	50,059
1970	97,983	25,846	0.26	72,137	68,751	14,510	0.21	54,241
1971	112,585	39,369	0.33	75,216	93,728	29,808	0.32	63,290
1972	130,564	51,351	0.39	79,213	114,559	44,808	0.39	69,751
1973	168,456	81,728	0.49	86,728	154,429	76,442	0.49	77,987
1974	221,189	129,756	0.59	91,443	165,212	76,442	0.46	88,770

*Due to differing fiscal years, this column indicates similar but not identical time frames for each town.

Source: Annual Report, Town of Waterford (various years).
Annual Report, Town of Plymouth (various years).
Additional unpublished data were provided by each town's assessor's office.

Although a number of factors intervened during the period 1968-73, in each town the aggregate response to the fiscal capacity increase in terms of tax effort was similar. As is shown in Table 2, if the entire period is considered, tax rate decreases occurred in each town. For Waterford, this change appears to have taken place primarily in the final year; however, its tax rate was somewhat inflated during the early 1970s due to the existence of a revenue fund designed to permit a change in the town's fiscal year. During the four years this fund was used, transfers to it ranged from 4% to 10% of total town expenditures. For Plymouth, the tax rate change was more uniform, and with the exception of 1972 in which the tax rate was modified to permit funding a capital item out of current revenues, decreased throughout the period following the siting.

In terms of the analysis of Section II, this suggests the two towns consumed additional quantities of both public and private services in 1973 as a result of the fiscal capacity change. A modified form of the elasticity of demand for public goods discussed above can be used to illustrate this point. This alternative statistic, the tax rate-price change elasticity indicates the percent the tax rate would change given a one percent change in the relative price of public to private goods.[16] Over the observed period, this elasticity may be calculated at -.27 for Waterford and -.18 for Plymouth, i.e., an average of one percent decrease in the price of public goods relative to private goods brought about a .27% decrease in Plymouth's tax rate and a .18% decrease in Waterford's tax rate. While this simple ratio is far too crude to employ in a predictive sense, it does illustrate the less than proportional response which each community made as fiscal capacity increased. That is, because the crudely measured tax rate elasticity was less than unity, it follows from the analysis of Section II that each community was able to

Table 2. Property tax rates in Plymouth, Massachusetts, and Waterford, Connecticut (in mills)

Year	Published tax rate	
	Waterford	Plymouth
1966	42.0	74.4
1967	42.0	78.8
1968	42.0	92.8
1969	42.0	97.2
1970	43.0	88.4
1971	43.0	79.6
1972	48.0	96.0
1973	31.0	76.4

Source: Annual Report, Town of Waterford (various years).
Annual Report, Town of Plymouth (various years).

consume both additional private and public goods as a result of the station sitings.

To test the assumption that the impact of the sitings contribute insignificantly to private sector activity and, by implication, to demands for public services, it is instructive to compare local tax payments and local wage payments associated with the sitings. To estimate these payments to the private sector, reasonable estimates of numbers of workers and salaries are employed. Actual data for these variables are unavailable. Once again, in the absence of reasonable parameter estimates, we omit consideration of multiple effects.

The results of preparing the hypothetical wage bill is presented in Table 3. Because of the employee assumptions chosen, each town is shown with an identical wage bill of $1.1 million. Pilgrim, by these calculations, makes somewhat larger tax payments than Millstone; but more importantly, in each case the tax payment far exceeds the estimated wage bill. In Plymouth, the tax payment comprises 84% of the total dollar impact of the station, and in Waterford, 78% of the total.

In per capita terms, the direct tax payment stood at $222 in Waterford and $247 in Plymouth, a figure which ranges from four to five times that of the direct wage impact. Of course, not all workers may choose to domicile themselves within the boundaries of the host community, and the spending impact will be initially diluted by the propensities of the respective city governments to spend outside their boundaries. Moreover, multiplier effects will differ due to leakage effects in both public and private factors. Thus, the siting of the nuclear stations in each case approximates but does not wholly fulfill the conditions required for the pure increase in taxable capacity. Note, however, that omission of the public sector in considering

Table 3. Approximate public and private sector direct economic impacts in Plymouth, Massachusetts, and Waterford, Connecticut, 1974

	Millstone	Pilgrim
Workers	90	90
Salary	$13,000	$13,000
Wage bill	$1,117,000	$1,117,000
Assessed value of station in 1974	$129,756,000	$76,442,000
Tax rate in 1974	.031	.076
Tax payment	$4,022,000	$5,810,002
Total direct impact	$5,139,000	$6,927,000
Percent tax	.78	.84
Per capita tax impact	$222	$247
Per capita wage impact	$62	$47

Source: Fiscal information, Annual Report, Town of Waterford and Annual Report, Town of Plymouth, Worker information is estimated.

local economic impacts from the sitings would have excluded roughly 80% of the direct economic impacts.

V. CONCLUSION

This analysis has argued that it is necessary to separate local economic impacts stemming from changes in the tax base from those occurring through local private sector changes. It has also suggested the concept of pure changes in taxable capacity as a device with which to analyze tax rate determination, once the public service "price" to local citizens is modified by tax base importation.

A major advantage of this approach lies in the ability to analyze the process through which local tax effort is determined with traditional economic tools. For the example given, a substantial increase in the tax base occurred with the siting of a nuclear power station. The indifference curve approach serves to highlight the fact that such a change modified the communities' feasible set of both private and public good combinations. Subsequent analysis pointed to the incentive communities have to increase public good consumption relative to private goods, since as the imported fraction of the tax base increases, the effective local price of public services decreases.

Admittedly, even in this relatively "pure" example, some direct changes to the private sector were evident, and these should not be excluded. Moreover, for the analyst seeking a blueprint for impact analysis, the graphical exposition of fiscal impacts is likely to be unsatisfactory. For these reasons, the third section sought to provide a structure from which to view both impacts to and leakages from the local economy within the format of a traditional macrotype model. The particular approach chosen for this

example emphasized explicit considerations of household- and government-consuming behavior and highlighted the impacts of important tax revenues on the community. Again, the framework, as developed here, is not directly operational. Yet, it does recognize and clarify the issues that must be addressed in an applied evaluation.

Although it has not been attempted here, one might easily conceive of further relaxation of the pure fiscal capacity change assumptions to apply this analysis to such issues as urban economic decline. If, for example, export-type industries are leaving central cities, a change in levels of both public and private economic activity would occur, but in general the "price" of public goods might well decline as imported tax dollars are lost. If it is the aim of the Federal Government to restore local public service levels, intergovernmental revenue programs might be aimed at restoring parity in the price-ratio through matching formulae. Moreover, declines in urban public sector activity levels, such as have been prepared for New York City, might have much more detrimental effects on the local economy that currently anticipated, if public and private multipliers have differing values.

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4. Ibid, p. 1.

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6. A variation of this model can be found in Helen F. Ladd, "Local Education Expenditures, Fiscal Capacity and the Composition of the Property Tax Base," National Tax Journal, Vol. 28, No. 2, June 1975. In this article, the author assumes that households effectively make public sector decisions and view all nonresidential property as "imported" tax base.

7. The use of a straight-line transformation between public and private goods assumes constant unit costs for each good at all levels of production. See Charles Waldauer, "Grant Structures and their Effects on Aided Government Expenditures: An Indifference Curve Analysis," Public Finance, Vol. 28, No. 2, 1973, p. 223.

8. For an excellent review of issues involved in the preference aggregation problem, see Jesse Burkhead and Jerry Miners, Public Expenditure (Chicago: Atherton-Aldine, 1971), Chapt. 5.

9. This conclusion holds strictly true only for the partial equilibrium case. In the next section, when a "dynamic" analysis is conducted by using a multiplier framework, it is evident that consuming behavior on the part of the public and private sector may influence the result, once the economy is "opened."

10. The price elasticity may be calculated as $[Pu_1\text{-}Pu_0/O\text{-}Pu_b] - [(O\text{-}Pr/Pr\text{-}Pr^1)/(O\text{-}Pr/OPr)]$.

11. In studying a reduced-form multiplier from a similar system, Charles Tiebout recognized the existence of supply side leakages, as well as demand side leakages, by including a parameter to convert local consumption to local income generated. For simplicity, this separate parameter is not included here, although it is possible to interpret A_2 and β as including both leakage effects. See Charles M. Tiebout, A Community Economic Base Study, Supplementary Paper No. 16, Committee for Economic Development, 1962.

12. U. S. Department of Commerce, Census of Population, 1970.

13. The 1975 population values are taken from information provided by the Federal State Cooperative Program for Population Estimates.

14. Revenue figures are derived from Annual Report, Town of Waterford and Annual Report, Town of Plymouth, 1968 and 1973.

15. U. S. Department of Commerce, Census of Governments, 1967 and 1972.

16. To calculate this statistic, defined as the ratio of percentage change in the tax rate to the percentage change in the contribution of the plant to taxable capacity, one first divides the assessed values not associated with the station into the total assessments, arriving at a "price." This price indicates the total revenue yield from a dollar of locally raised revenues. It is equal to unity when a zero value is

entered for the station and increases as the station's value increases. The crude elasticity is then estimated by dividing the percentage change in the tax rate by the percentage change in the price ratio.