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Donald E. Frey

Recent economic base multiplier literature is largely empirical, relying implicitly for theoretical justification on a model of the local economy that is little changed since Tiebout (1962). The few who have addressed this theory list several shortcomings (Heilbrun 1981; Pleeter 1980; Hirsch 1973; Pfister 1976). Criticisms fall into four categories: (1) failure of the model to reckon with supply inelasticities; (2) drift over time of estimated parameter values due to evolving local economies; (3) focus on exports to the exclusion of other autonomous sources of demand; (4) weaknesses that any Keynesian consumption function exhibits. In addition, estimated economic base multipliers exhibit wide variability.

This paper modifies the Keynesian style model of the local economy with several goals in view. The first is to develop an implication of Tiebout's work that suggests two conceptually distinct multipliers exist for local economies. Second, the paper introduces a simple supply side to the model without abandoning its essential demand driven nature. The third aim is to calculate magnitudes of these multipliers for ranges of parameter values, thus providing a basis for judging the credibility of multiplier magnitudes estimated statistically.

No effort is made to deal with some of the objections raised against the local multiplier. As Pleeter argued, parameter drift is of concern only in the long run and can be dealt with by empirical devices. The focus on exports rather than other sources of demand represents no substantial problem, for any fully elaborated model can generate multipliers for any autonomous demand source contained in the model. Finally, objections to the Keynesian consumption function should apply with much less force in the local economy. For example, the Ricardian equivalence proposition, which holds that offsetting consumption behavior by households negates the multiplier effects of government deficit spending, has no local equivalent. That goods exported by a local firm are paid for by borrowed federal funds should have no bearing on the consumption behavior of local residents, for their share of any future tax obligation to cover the purchase is nil.

I. CONTEXT

Tiebout recognized that in local economies novel leakages, such as wage payments to nonresidents or payments for intermediate inputs, would play an important role in defining a local export base multiplier; however, he did not formally model these insights. The Tiebout multiplier was for local residents' incomes in response to an initial increase in those incomes. While this could be applied directly to transfer payments, dividends, or the like, one normally would have to convert the sales of an export base firm into local residents' income before applying the appropriate multiplier. This is the approach taken in some British literature (Sinclair and Sutcliffe 1978; Brownrigg and Greigg 1975), where first-round purchases are adjusted by an "income generation coefficient" to approximate first-round local income before being multiplied by a conventional multiplier to produce an "effective multiplier" for local income. A more systematic alternative to the income generation coefficient would be to respecify the structure of the local economy to derive multipliers consistent with

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local income leakages, such as those to nonresident workers or suppliers of imported intermediate inputs. Two distinct multipliers would emerge from such models: a local expenditure multiplier, and the local residents' income multiplier (hereafter, LRI multiplier), which would be akin to the multiplier for the household sector in local input–output models (Harmston 1983).

Multiplier theory also needs to deal with supply side constraints on induced growth. That the local economy is not free of local factor inelasticities is well known (Hirsch 1973; Anderson 1976; Ghali, Ariyama and Fijiwara 1978; Pratt 1967). Yet this literature provides no guidance for a relatively direct modification of the multiplier; direction may be taken, however, from the macroeconomic multiplier, where money supply inelasticity is addressed in the IS–LM paradigm.

Empirical multiplier estimates typically use employment as a proxy for income, the theoretically appropriate variable. These estimates are highly sensitive to the method by which basic and nonbasic industries are separated (Gerking and Isserman 1981), the precise structure of regression equations, and the inclusion or not of control variables. Lewis (1976) noted that a single data base could "yield vastly different values of the multiplier." Gibson and Worden (1981) found the multiplier to be sensitive to careful adjustments to data for consistency (e.g., conversion of jobs to full time equivalents). A structural model of the local economy, yielding multipliers stated in terms of the underlying parameters, should provide a check on theoretically implausible magnitudes of empirical multipliers.

II. SEVERAL STRUCTURAL MULTIPLIERS

Multipliers for three progressively complex local economies are developed in this section. Any source of expenditure or income that is exogenous is basic to the local economy, but the convention is adopted here of deriving explicitly only the multiplier for local export sales. The economy portrayed in Model 1 is a strictly conventional Keynesian representation that serves mainly as a benchmark for comparison.

Model 1

The benchmark local economy is self-contained with respect to factors of production (i.e., no nonresident commuting workers, etc.), and produces one hundred percent of the value added of final sales (i.e., no import of intermediate goods); import and export of final goods or services occurs. Local product measured from the demand side is:

$$E = C + I + G + X - M, \qquad [1a]$$

where E is aggregate expenditure on local product, C is consumption expenditure by local residents on final goods that are locally produced or imported, I is local investment (here exogenous and so part of the basic sector), G is government purchases of local product (here also viewed as basic), X is (autonomous) exports of local product to both higher levels of government and to the nonlocal private sector, and M is imported final goods, which account for some portion of C. (The import of intermediate inputs will be accounted for by a separate value-added parameter.) The conventional consumption function is:

$$C = C^* + b(Y - T), \qquad [2a]$$

where C^* is an autonomous consumption component, b is the marginal propensity to consume, T is taxes net of transfers for all levels of government, and Y is income derived from local production; in Model 1 all income generated by E accrues to local residents by assumption. The model is completed by making taxes a function of income:

$$T = T^* + tY, \qquad [3a]$$

where T^* is an autonomous component of taxes and t is the rate. Similarly,

$$M = M^* + m(Y - T), \qquad [4a]$$

where M^* is autonomous imports and m is the propensity to import. Solving for equilibrium (where expenditure on local product, E, equals incomes generated from local product, Y) and differentiating the equilibrium value of Y with respect to X gives the multiplier:

$$\frac{dY}{dX} = \frac{1}{1 - b(1 - t) + m(1 - t)}, \qquad [5a]$$

which is the conventional multiplier for an open economy.

While the restrictiveness of the assumptions of this model is apparent, the model also suffers from an internal inconsistency. If the equilibrium condition is rewritten as $S - I = G - T + X - M$, it is clear that in equilibrium local savings may exceed the local use of savings (investment), and vice versa. But if local savings exceeds local use of savings, financial assets from outside the local economy must be accumulated, and income produced by those assets must be received within the local economy. Yet Y was defined as income derived from local production; hence the Model 1 notion of income is not consistent with any equilibrium values other than where $S = I$.

Model 2

In order to correct these shortcomings, the local economy is opened with respect to factors of production and intermediate inputs, and the notion of income is amended: E = expenditure on local product, inclusive of value added by nonlocal producers of intermediate inputs; Y = all incomes derived from sale of local product, including incomes of nonresident commuting workers, nonresident owners of local firms, and incomes of workers and owners of nonlocal suppliers of intermediate inputs; RY = income derived from sale of local product accruing to local residents; RYN = income derived from nonlocal sources accruing to local residents (exogenous in a short-run model); LRI = $RY + RYN$. If v is the fraction of the value of local product that is added locally, and if r is the fraction of local value added that accrues to local residents, then $RY = rvY$.

These modifications produce the following functions:

$$\begin{aligned} C &= C^* + b(RYN + RY - T) \\ &= C^* + b(RYN + rvY - T), \end{aligned} \qquad [2b]$$

$$T = T^* + t(RYN + rvY), \qquad [3b]$$

$$M = M^* + m(RYN + rvY - T). \qquad [4b]$$

Solving this model for equilibrium and differentiating with respect to autonomous X yields:

$$\frac{dY}{dX} = \frac{1}{1 - brv(1 - t) + mrv(1 - t)}. \qquad [5b]$$

For many purposes the relevant multiplier is the LRI multiplier:

$$\frac{dLRI}{dX} = \frac{rv}{1 - brv(1 - t) + mrv(1 - t)}. \qquad [6b]$$

The difference between [5b] and [6b] is that the latter shows the impact of an extra $1 export sales on local residents' incomes, while the former shows the impact of that $1 on the incomes of anyone supplying factors or intermediate inputs to local producers (which equals the multiple effect on E). If the parameters r and v take the value one, the model becomes mathematically equivalent to Model 1, except for the exogenous RYN. If r or v approach zero, the multiplier [5b] approaches its minimum value of one, and the LRI multiplier [6b] approaches its minimum of zero. (In this case the local firm is simply a conduit for income payments to nonresident workers or owners, or to nonlocal suppliers of intermediate inputs.) That the LRI multiplier could be less than one is consistent with British work finding "effective multipliers" of less than one, and with input–output multipliers for the household sector that are less than one.

Model 3

Although the kinds of inelasticities that restrict national-economy multipliers (i.e., inelastic money and labor supply) should be of little concern for local economic expansion (since capital and labor should be available in highly elastic supply from national markets), the inelasticity of land cannot be ignored. Induced changes in local land prices could dampen any local expansion of income by increasing the cost of locally produced goods relative to those produced outside the city. (In the event that inelasticity of another factor were of concern, the following analysis could be generalized, with appropriate modification.)

The import function may be modified to include the impact of local land prices on imports (omitting RYN, which adds nothing to the analysis):

$$\begin{aligned} M &= M^* + m(RY - T) + dP \\ &= M^* + m(rvY - rvtY) + dP, \end{aligned} \qquad [4c]$$

where the reduced form coefficient d shows the effect of land prices, P, on imports into the local economy without elaborating all the microeconomic structural linkages. Qualitatively, upward pressure of local land prices increases the cost of local production, thereby making imports to the local economy relatively less expensive and increasing M.

Because exports are no longer purely autonomous, but depend on local land prices which influence costs and competitiveness of local exports, an export function is introduced:

$$X = X^* - gP. \qquad [7c]$$

In addition to the purely autonomous component, X^*, exports depend on their relative price, which is influenced by land prices in the local economy. The coefficient g relates exports to local land price P.

A simple local land market may be represented by

$$D = hvY - jP, \qquad [8c]$$

$$S = S^* + wP. \qquad [9c]$$

Demand for local land, D, is a function of local value added, vY, and land prices, while the land supply, S, consists of an exogenous component, S^*, plus idle or agricultural land that may be added to the supply in response to price changes; h, j, and w are coefficients. In equilibrium, $S = D = L$. After this expanded model is solved for the equilibrium value of Y, the multiplier is found by differentiating with respect to autonomous exports x^*:

$$\frac{dY}{dX^*} = \frac{1}{1 - brv(1 - t) + mrv(1 - t) + Z} \qquad [5c]$$

where

$$Z = \frac{vh(g + d)}{j + w}. \qquad [10]$$

The LRI multiplier is

$$\frac{dLRI}{dX^*} = \frac{rv}{1 - brv(1 - t) + mrv(1 - t) + Z}. \qquad [6c]$$

It is shown readily that $d = e(M/P)$, $g = -e^*(X/P)$, $vh = e^{**}(L/Y)$, $j = -e'(L/P)$, $w = e''(L/P)$, where e is the elasticity of imports with respect to land price, e^* is elasticity of exports with respect to land price, e^{**} is the elasticity of land demand with respect to local product, e' is the elasticity of land demand with respect to land price, and e'' is elasticity of land supply with respect to land price. This permits the reinterpretation of Z as

$$Z = \frac{e^{**}(-e^*[X/Y] + e[M/Y])}{-e' + e''}. \qquad [10a]$$

Inspection of the term Z shows plausible qualitative results. A large value of e' suggests that other inputs are readily substituted for land, thereby attenuating any restrictive effects of an inelastic land supply; that is, large e' reduces the magnitude of Z and allows the multiplier to take larger values. If land were in completely fixed supply, so $e'' = 0$, the value of Z would be of maximum value, given other parameters, and the multiplier would be reduced in value. A completely inelastic land supply would not reduce the multiplier to zero, because production would still increase so long as input substitution were possible; but if both e' and e'' were zero, then Z would be indefinitely large and the multiplier approach zero. The parameter e^{**} captures the scale effects of local production on the demand for land; greater economies of scale in local production would reduce the magnitude of e^{**} and lessen the constraining effects of an inelastic land supply. To the degree that export or import elasticities, e^* and e, with respect to land prices are small, and to the degree that the weights (the proportions of local product being exported or imported) are small, the effect of land inelasticity also is attenuated. That is, a reduction in the value of these terms reduces Z and allows the multiplier to take magnitudes dictated by conventional parameters. The elasticities e^* and e would be smaller if land costs were but a small portion of total costs of production in the local economy, or if, for the usual kinds of reasons, demand for export goods or import goods was relatively insensitive to prices. A discussion of the probable values of these parameters, and the value of Z, appears in the Appendix.

TABLE 1
VALUES OF EXPENDITURE MULTIPLIER [5c] AND LRI MULTIPLIER [6c]
Parameters: b = .9, t = .2

Z:	.05		.25		.5	
	[5c]	[6c]	[5c]	[6c]	[5c]	[6c]
m = .1						
rv = .9	2.1	[1.9]	1.5	[1.4]	1.1	[1.0]
rv = .6	1.5	[0.9]	1.2	[0.7]	0.9	[0.5]
rv = .3	1.2	[0.4]	0.9	[0.3]	0.8	[0.2]
m = .3						
rv = .9	1.6	[1.4]	1.2	[1.1]	0.9	[0.8]
rv = .6	1.3	[0.8]	1.0	[0.6]	0.8	[0.5]
rv = .3	1.1	[0.3]	0.9	[0.3]	0.7	[0.2]
m = .6						
rv = .9	1.2	[1.1]	1.0	[0.9]	0.8	[0.7]
rv = .6	1.1	[0.7]	0.9	[0.5]	0.7	[0.4]
rv = .3	1.0	[0.3]	0.8	[0.2]	0.7	[0.2]

III. SENSITIVITY ANALYSIS OF MULTIPLIERS

Empirical multiplier estimation often yields highly divergent magnitudes, some quite large (see above). Alternative information on multiplier magnitudes is possible by inserting parameter values into structural multipliers such as [5c] and [6c]. Although parameter point value may not all be known with certainty, ranges of parameter values based on a priori considerations usually can be specified. By use of sensitivity analysis, this section proposes to answer whether high variation in the values of the underlying parameters necessarily produces high variability of the multiplier magnitudes, and where the plausible upper limit of multiplier magnitude lies.

Because of the addition of Z, r, and v in the denominator, modified multipliers presented in this paper are presumed to be smaller than most conventional estimates. Therefore, selection of parameter values is designed to challenge this hypothesis. Ranges of all parameters overlap values that favor large multiplier magnitudes, and ranges are large enough to see if high variability in multiplier values can be induced. Parameters that are not specific to the local economy are assigned point values, which are intentionally biased toward finding large multiplier magnitudes. The marginal propensity to consume, b, and the tax rate, t, are not specific to the local economy, and in calculating Table 1 were set at b = .9, and t = .2. Because the parameters r and v appear only as a product in the multipliers, they are treated as a product in Table 1.

Of the 27 reported expenditure multipliers in Table 1 only one exceeds 2.0 in value, and this result occurs only for values of underlying parameters that could be ruled out a priori for most local economies (i.e., for m = .1, a community would have to be almost self-sufficient in consumer goods, and for rv = .9, local firms would have to employ almost no commuters and to purchase almost no intermediate inputs from outside the local area—both improbable for most local economies). The expenditure multiplier takes values greater than 1.2 in only four of 27 cases and less than 1.0

in 12 of 27 cases. The interdecile range lies between .7 and 1.5, around a low median value of 1.0. Considering that the extreme values in the omitted top decile are based on combinations of a priori improbable parameters, the largest theoretically plausible values for multipliers cannot be much larger than 1.5, and are probably even smaller, a finding that should challenge typically larger empirical results. Clearly, accounting for land inelasticity profoundly reduces the range of theoretically plausible multiplier values.

The small interdecile range for multiplier [5c] reveals that the multiplier is not highly sensitive to parameter variation. Even if all three parameters were fully variable, the interdecile range, effectively covering all plausible multiplier values, would be only .8 in absolute value.

Table 1 also gives, in brackets, values for the LRI multiplier [6c], which for local planners and policy makers is often more important than the expenditure multiplier. The interdecile range is small, between .2 and 1.4. Again, the omitted top decile contains values based on implausible parameter values. On theoretical grounds, then, the multiplier most relevant for local decision making is small, and potentially less than one in value.

IV. CONCLUSIONS

Leakages from a circular flow unique to the local economy imply that two local multipliers should be defined. A simple land market can be grafted to the model to show how inelasticity of one factor of production can modify the formulation of the demand-driven multiplier. Sensitivity analysis of the multipliers to parameter variation shows that the multipliers are almost certainly relatively small and therefore constrained not to be highly variable.

APPENDIX
The Range of Z

The term Z is a composite of several elasticities and weights. The weights X/Y and M/Y are city specific and are limited only to the range of zero to 1.0. These weights are multiplied by the elasticities e^* and e, respectively. Since the elasticities are likely to be less than one also, the products must be less than one, probably considerably less. The export and import elasticities with respect to land prices, e^* and e, are presumed to be small because the percentage of total costs of production attributable to land is small. Therefore, even a large percentage increment in land prices will produce only a small percentage increase in the cost of local product; in turn, this will produce only a small impact on imports or exports, even if their demand is elastic to local product price.

The other term in the numerator is e^{**}, the elasticity of land demand with respect to local production. The term e^{**} reflects the demand for land as the economy moves along its expansion path. Barring strong arguments for scale economies or diseconomies for an entire local economy, e^{**} should be close to one in value. Altogether, these considerations suggest that the numerator of Z is less than 1.0 in value.

The denominator of Z is the sum $-e'$ and e'', the land demand and supply elasticities with respect to own price. Muth (1968, 291) presents evidence that e' is about $-.75$ for residential land, and probably also less than unit elastic (the same order of magnitude) for nonresidential land. Muth also concludes that the elasticity of supply is "at least" 1.3 if agricultural land can be converted to urban use. Thus, the denominator is about 2.0 in value, or possibly larger, depending on more precise elasticities.

With the numerator almost certainly less than 1.0, possibly much less, and with a denominator possibly larger than 2.0, the most likely range of values for Z is from nearly zero to 0.5.

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