Test of the Economic Base Theory and Estimation of the Multipliers—San Diego Case Study *

ISAMU GINAMA

Introduction

In this paper, an attempt is made to test the plausibility of the fundamental postulate of the economic base theory in regional economics and to estimate multipliers on an industry basis. As Heilbrun [3, chap. 7] reasonably indicates, the economic base theory is termed a theory exactly because it assumes the existence of causality between basic and nonbasic (and total) activities in the region. This postulate is the keystone of the idea of the basic - nonbasic approach, and its rejection would cast an essential doubt on the conventional use of the concepts of basic and nonbasic activities. Thus, the statistical test of the postulate is expected to provide us with theoretical basis (not the judgement from the standpoint of its practical use which seems to be prevailing) to posit the idea in its appropriate place.

Although no attention is paid to the problem of the stability of multipliers, their numerical values for each industry will be calculated and compared to the other authors estimates. Also, the relevance of taking account

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of the changes in each industry's employment for predicting the total employment will be shown in terms of significance tests on estimated coefficients.

I. Review of the economic base theory

In explaining the expansion of regional economic activity, the economic base theory assumes that the "basic" (export) sector's growth (in terms mainly of employment, or some other measure like value added) leads to a subsequent expansion of the "nonbasic" sector, and thus to the growth of the whole regional area. Homer Hoyt [5] mentions the development of the thought. As an economist of the Federal Housing Administration in 1936, he tried to evaluate cities as to their future growth in employment for mortgage risk insurance purposes. His realization was that there were certain types of employment that were called basic, and were the "primary cause" of urban growth. Simplicity and quick applicability were his original requirment under the time constraint, for the mortgage risk system had to be set up to handle actual loans that were being processed in large volume. He dicided to reduce the employment types to be studied to "the ones that controlled all the rest".

To put the idea compactly, suppose the total employment (E) of a region was somehow divided into basic (BA) and nonbasic (NBA) employment. Then the relation $E = NBA + BA$, or $E / BA = NBA / BA + 1$ holds, and the economic base theory postulates that the variation of BA causes NBA (and therefore, E) to change in the same direction where the total to basic ratio E / BA is called the employment multiplier. The ratio E / BA is assumed to be fairly stable over time, and thus the marginal and average quantities are regarded as virtually equal.

Thus, in forecasting future regional employment to which the economic base theory is mainly applied, the predicted value of future basic employment is multiplied by the ratio E / BA to get the prediction of total employment E.

The merits of this method are 1) the analyst can concentrate only on the export trades instead of predicting changes in each industry, 2) the export trades are likely to be characterized by large firms, and thus the costs of making predictions are considerably reduced, and 3) the method makes use of employment which is the most easily available local data (Heilbrunn [3, chap. 7]).

On the other hand, the drawbacks of this model are 1) the neglect of autounomous investment, technical progress, and immigration, and 2) the value of the multiplier might continuously and unpredictably change (stability of multiplier) (Richardson [8]).

II. The location quotient method

Let Ei, E, ENi, and EN be local employment in the i th industry, total local employment, national employment in the i th industry, and total national employment, respectively. The location quotient is defined as (Ei / E) / (ENi / EN) which measures the relative concentration of the i th industry in the region compared to the size of the industry on the nationwide basis (the benchmark does not need to be the national rate. Pfouts and Curtis [7] used an average of 40 Metropolitan areas as the benchnark) . Although the location quotient is useful as a descriptive measure in urban studies, it has been used as an export allocator in relation to the economic base theory due to the lack of any satisfactory way of classifying industries in the region into basic and nonbasic sectors.

In doing so, the location quotient method (LQM) makes the following assumptions (Heilbrun [3, chap. 7]): 1) patterns of consumption are geographically invariant, 2) labor productivity is geographically invariant, 3) each industry's products are homogeneous. Under these assumptions, the LQM is applied in the way that if the location quotient of the i th industry in a certain region is greater than 1, then the industry is producing more output than being necessary for local use, and thus it is interpreted as an export (basic) industry. Otherwise, an industry is included in the nonbasic sector. This is a convenient and easily applicable method from the standpoint of the economic base theory. However, this method often leads to seemingly unreasonable classifications of industries. For example, Daly [1] discusses the nature of localised (nonbasic) industries, and shows an a priori selection of localized industries. He picked up the public works, building, building supply, and distributive industries as the localized. But, table - 1 of San Diego's location quotient shows the exactly opposite results (in this table, large quotients in the Whole Sale-Retail Trade, and Government columns might be interpreted by the conditions specific to San Diego: tourism and the existence of the large scale military bases) . This contradiction seems to be originated from a set of quite unrealistic assumptions made in the LQM. Heilbrun [3, chap. 7] regards the third assumption as the most unrealistic, but assumptions 1 and 2 do not seem to be less unrealistic. Thus, one always has to take this problem into account when making use of the LQM. Nevertheless, in the following chapter, we are going to apply this method to form the basic and nonbasic sector of San Diego along with an a priori standard only because of the difficulty of finding any other appropriate method. By doing so, it is expected that statistical tests of the conventional economic base theory consistent with the LQM (Pfouts, Curtis [7] and Hildebrand, Mace [4]) are made.

Ⅲ. Causality test of the economic base theory

Granger [2] describes the testable concept of causality. Assuming X (t) , Y (t) to be two stationary time series ~~whit~~ with zero means, the simple causal model is

$$X(t) = \sum_{i=1}^{m} a(i)\, X(t-j) + \sum_{j=1}^{m} b(j)\, Y(t-j) + e(t)$$

$$Y(t) = \sum_{j=1}^{m} c(j)\, X(t-j) + \sum_{j=1}^{m} d(j)\, Y(t-j) + n(t)$$

where e (t), n (t) are uncorrelated white noise series. Then, the definition of causality is that Y (t) is causing X (t) if some b (j) is not zero, and similarly, X (t) is causing Y (t) if some c (j) is not zero. If both of them are observed, a feedback relationship is said to exist between X (t) and Y (t).[1)]

In applying this test, however, the feedback effect was discarded in accordance with the economic base theory, therefore, single equation method was adopted. Also, unprocessed, nonstationary series was used in the actual test procedure. This means that the existence of causality might change over time, and one would talk of causality at a certain period in time. It must be noted that the causality tests done in this project are subject to these conditions.

Returning to the linear causal model

$$X(t) = \sum_{j=1}^{m} a(j)\, X(t-j) + \sum_{j=1}^{m} b(j)\, Y(t-j) + e(t) \qquad (1)$$

the equation was estimated by OLS, and an F test was applied to see if any b (j) is statistically different from zero. If the calculated F—value exceeds a certain critical point, then the hypothesis that all b (j) 's are jointly zero is rejected, and the existence of causality is inferred.

Under this scheme of test procedure, three ways of sector classification and two ways of the choice of the dependent variable were made in relation with the economic base theory.

Let the definition of symbols be as the following.

Employment of each industry

E1: Mining, E2 Construction, E3 Manufacturing,

E4: Transportation and Public Utilities,

E5: Wholesale and Retail Trade,

E6: Finance, Insurance, and Real Estate,

E7: Services, E8: Government, E. Total.

Using these definitions, the LQM gives two types of sector classification, and an a priori standard adds one more division of sectors. They are

$$BA1 = E2 + E5 + E7$$
$$NBA1 = E1 + E3 + E4 + E6 + E8$$

$$BA2 = E2 + E5 + E7 + E8$$
$$NBA2 = E1 + E3 + E4 + E6$$

$$BA3 = E3 + E6$$
$$NBA3 = E1 + E2 + E4 + E5 + E7 + E8$$

where BAi and NBAi stand for basic and nonbasic employment, also the classification with i = 1, 2 is based on the LQM, and the one with i = 3 was based upon the a priori standard. The difference between i = 1 and i

= 2 is simply in whether the government employment E8 is included in the basic sector or not: BAl does not contain E8, but BA2 dose. As Daly [1] refers, government employees migt be mainly servicing the local area, but the extensive military presence in San Diego might put an important role on military personnels in providing the whole other area with national defense services. This is the reason for making two classifications based on the LQM. An a priori selection was tried to avoid probable bias resulting from the LQM as described above.

The results of the test is shown in table—2 where the symbols N and T stand for the nonbasic and total employment being used as the dependent variables, respectively, and 1, 2, 3 are referring to three types of classifications, ie i = 1, 2, 3 (F—values were obtained based on the estimated equations shown in table—3. More explanation is given in footnote (2)) . The data are San Diego's employment for each industry, and the observation period is from December 1963 to December 1983 on a quarterly basis. The source of data is "Employment and Earnings" , Department of Commerce.

All relevant 5 % critical values are approximately 2.00. Thus, except for N—2 entry in the table, the hypothesis that all b(j) 's in the model (1) above are jointly zero is accepted leading to the rejection of the causality postulate in the economic base theory. However, before deriving this conclusion, the relationship between significant (in N—2 entry) and insignificant F values (in T—2 entry) has to be reasonably interpreted because this, result contradicts the intuition that if the basic causes the nonbasic, then it is supposed to cause total employment either because the total employment is simply the sum of basic and nonbasic employment, and the variation of the basic trivially causes its own variation, therefore, if it causes the change in the nonbasic, it should cause the total employment change, too. Although this argument seems to be quite natural, it is not necessarily the case. Using a simplified version, the equation for N—2 entry is written as

$$NBA = aNBA(-1) + bBA(-1) \tag{2}$$

Due to the fact that $E = BA + NBA$, the model (2) is rewritten as

$$E = BA + aNBA(-1) + bBA(-1) \tag{3}$$

which is not in the form for the test appearing in T entries of table—2: the equations for T entries can be written as

$$E = cE(-1) + dBA(-1) \tag{2$'$}$$

that is,

$$NBA = c'NBA(-1) + d'BA(-1) - BA \tag{3$'$}$$

which takes the form

$$NBA = eNBA(-1) + eBA(-1) - BA \tag{3$''$}$$

when excluding $BA(-1)$ term out of equation (2)'. So, a comparison between (3) 'and (3)" is made in the test for T entries, and this reduces to the test of imposing the restriction of indentical parameters in (3)".

Based on this reasoning, the significant results in the N—2 entry is interpreted as showing that although BA2 causes NBA2, the causality is incomplete in the sense that it is not sufficient enough to cause the total employment variation. And, in the sense that the economic base theory assumes the consistent causality from BA to NBA, and further to E, the T entries of the table have to be interpreted as dominating the N entries.[3)]

For comparing the results above with other author's, only one case seems to be available.

Pfouts, and Curtis [7] adopted the LQM to get basic and nonbasic sectors, and tested the economic base theory by calculating correlation coefficient between basic and nonbasic employment, and by observing its statistical significance. Thier results were negative to the theory when using the national rate as the benchmark in the LQM, but were positive with the benchmark of the average of the 40 Metropolitan areas.

However, the correlation coefficient is not a good measure for this purpose simply because it does not reflect any causality. Many sorts of spurious relations will show high correlation, therefore, the significance test of the correlation coefficients dose not seem to be an appropriate for the purpose of detecting the causal relationship.

Hildbrand, Mace [4] , and Daly [1] adopt the economic base theory for calculating the multipliers. But, they seem to implicitly assume the causal relationship by making BA a regressor in their regressions.

No other attemt seems to have been made for the causality test about this problem. This would be primarily because the economic base theory has been only for practical use. After the multipliers turned out to be fairly unstable, the theory itself lost its attraction. It seems that this should not be the case unless having a good forecasting tool without sufficient theoretical background is all right.

Ⅳ. Measurement of the multipliers

Apart from the division of the total employment into the basic and nonbasic sectors, each industry's multipliers are calculated in this chapter. By doing so, it is expected that the numerical values and thier statistical significance will shed light on the understanding of the each industry's relative importance in the region in terms of their influence on the total employment.

For this purpose, the equation

$$E(t)=\sum_{j=1}^{P}\sum_{i=1}^{8}w(j)a(i)Ei(t-j)$$

$$=w(1)(a(1)E1(t-1)+a(2)E2(t-1)+\cdots\cdots+a(8)E8(t-1))+$$

$$w(2)(a(1)E1(t-2)+a(2)E2(t-2)+\cdots\cdots+a(8)E8(t-2))+$$

$$\cdots\cdots$$

$$+w(p)(a(1)E1(t-p)+\cdots\cdots+a(8)E8(t-p)) \tag{4}$$

which is derived from the equation

$$E=\sum_{j=1}^{P}\sum_{i=1}^{8}b(i,j)Ei(t-j) \tag{5}$$

by imposing nonlinear restriction $b(i,j)=w(j)a(i)$ was estimated by iterative method where $b(i,j)$, $w(j)$, $a(i)$ are parameters of the models (4) and (5), and P = 5 was assigned to keep sufficient degrees of freedom.

Let the model (4) be

$$E(t)=f(q,X(t))$$

where q and X (t) be a vector of coefficients and a matrix consisting of Ei's. Then, the Gauss—Newton method

$$q(i+1)=q(i)+(Z'Z)^{-1}Z'e$$

is available to estimate q where

$$\partial f/\partial a(i)=w(1)Ei(t-1)+\cdots\cdots+w(p)Ei(t-p)=Si$$

$$\partial f/\partial w(j)=a(i)Ei(t-j)=Vj$$

$$Z = [S1, \cdots, S8, V1, \cdots\cdots\cdots, Vp]$$

and e is a residual vector obtained by making use of q (i) in the model (4). This iteration is continued until R^2 gets close enough to zero.

The method used here is not this, but an equivalent one that starts by giving a set of initial values to a(i)'s (or w(j) 's) to estimate w(j) 's (or a(i) 's) by OLS, then giving the estimated w(j) 's, estimates a(i) 's, and so forth, continuing until $\Delta q = q(i+1) - q(i) \simeq 0$ (There is no deep reason for choosing this except for the reduction in the number of regressors in each step and an easy access to the ready—made OLS program).

Their equivalence is shown by noting that R^2 in the Gauss—Newton iteration is written as $\hat{e}'\hat{e}/e'e$ where $\hat{e}$ is the estimated value of e in i +1 th iteration ($\hat{e}$ and e are in terms of the deviation from the mean $\bar{e}$, but $\bar{e} = 0$ due to e being residual). But $e = Z(\Delta q) = Z(Z'Z)^{-1}Z'e$ where $\Delta q = q(i+1) - q(i)$. Therefore, $\hat{e}'\hat{e} = e'Z(Z'Z)^{-1}Z'Z(Z'Z)^{-1}$ $Z'e = e'Z(Z'Z)^{-1}Z'e$

Let $Z'e = y$, then $\hat{e}'\hat{e} = y'(Z'Z)^{-1}y$ where $(Z'Z)^{-1}$ is a positive definite matrix. Thus, when $R^2 = \hat{e}'\hat{e}/e'e \simeq 0$, $y = Z'e \simeq 0$ holds, but this implies $(Z'Z)^{-1}Z'e \simeq 0$ resulting $q(i+1) - q(i) \simeq 0$ (Practically, a simultaneous difference ratio (figuratively $\Delta q/q \leqq 0.01$) was used as a convergence standard). Due to the equivalence of the two methods, the variance —covariances for $q(i+1)$ is obtaind from regressing e in the ith iteration on Z.

Table—4[4)] shows the estimated coefficients of the model (4) where w (1) = 1.0 is the additional prior restriction to identify model (4) in relationship with model (5) (b (i, j) = w(j) a(i) = (1 / 2 w(j)) (2a(i)). A set of values of w(j) and a(i) which is consistent with b(i,j) is thus not unique. But, the restriction w(1) = 1.0 determines a unique set of w(j) and a(i) through their relative sizes in the estimation).

Table—4 shows that Mining (a(1)), Transportation and Public Utilities (a(4)), and Finance, Insurance and Real Estate (a(6)) industries do not affect the total employment significantly(But, a(6) is significant in 10 % level in two tailed test) while among significant coefficients, Construction and Manufacturing industries show relatively small effects, and Services, Whole Sale and Retail Trade, and Government show relatively large effects. This tendency might be interpreted in terms of San Diego's locational characteristics mentioned above. Based upon the estimates in table—4, the long run multipliers are obtained as $a(i)\sum_{j=1}^{p} w(j)$ for the ith industry. They are shown in table—5 while another set of multipliers were calculated after suppressing insignificant coefficients out of table—4, and were shown in table—6.

After applying the LQM as export allocator, Hildebrand and Mace [4] calculated the multiplier (NBA / BA) of Los Angels County by simply regressing NBA on BA (using time series monthly date) without any lag effects in their equation. They estimated NBA / BA = 1.248, therefore, E / BA = 2.248 which is much higher than the values in table—5 and 6.

Daly [1] calculated the multiplier NBA / BA also by a simple regression while making use of cross section data from two points in time. He adopted an a priori separation of sectors, based upon reasoning at the beginning of his paper. His estimate was NBA / BA = 1.042, so E / BA = 2.042 which is less than Hildebrand and Mace' s estimate, but still higher than the values in table—5 and 6.

Terry [9] rather works on rigorous derivation and interpretations of the export multipliers, but shows the empirical estimates in the range of (1.96, 3.18) which is higher than the present study.

This difference in multipliers between the present study and other previous works might be suggesting the openness of San Diego; that is, in San Diego the increase in exports tend to induce a significant increase in imports. This explanation was applied to the small region case study of Portsmouth, NH by Weiss and Gooding [10] .

Their export sector consists of private export, civilian employment at the Naval Shipyard, and total (military and civilian) employment at the Air Force Base, and multipliers for these sectors fall in the range (1.4, 1.8) which is quite consistent with present study.

They attribute the small magnitude of multipliers to the small size of the Portsmouth area economy, its relative specialization in defense activity, and its low income levels, all of which explain the openness of the region.

The first and third reasons do not apply to San Diego, but it has relative specialization in defense and tourism activity, and further it is a growing city. A growing regional economy would need considerable importing of goods and services from other areas. Thus, the openness argument may apply to San Diego.[5)]

Conclusion

The existence of causality in economic base theory was statistically rejected in San Diego case study. In some sense, this result is quite natural because even in determining the variation of a single economic variable on the regional basis, mutual interdependence of many factors has to be taken into account just as in the case of the national economy. It is not hard to understsnd the tendency that when the scope of the analysis gets narrower, some characteristic activities in the region get more vivid, and one is tempted to attribute observed results to those activities. However, when the purpose of the work is in forecasting, which requires a sort of accuracy, a more sophisticated point of view seems to be required.

North [6] and Heilbrun [3, chaps. 1, 2, 3] discuss urban growth historically, and North supports the economic base theory. But, his arguments seem to refer to the basic sector as the one engaging in the notable production characterizing the region and dose not seem to insist on the existence of causality numerically measured above.

Thus, the rejection of causality dose not need to reject the role played by characteristic industries in the region. But, the stable and precise causation should be regarded with doubt.

The result of the causality test strongly depend on the classification of sectors. On this point, the estimation of the model (4) will cast light on the relative importance of each industries in terms of their influence on the total employment.

Footnote

(1) If the variables are such that the contemporaneous terms are necessary, the more general model which allows for instantaneous causality was also introduced. For the multiplier effect to start operating, however, it is assumed here that a certain length of time is necessary, and thus if there exists causal relation between the economic base variables, it has to be detected by the simple model (Weiss, Gooding [10] refers to half a year lag as operating in the multipliers. This could provide the above assumption with an empirical justification due to the quarterly data used in this study).

(2) A pair of equations which gave the values in table—2 are as follows (equation numbers are related to table—3) : equation 1 and 2 for N—1,

equation 3 and 4 for N−2 (F (12, 51)), equation 5 and 6 for N−2 (F (12, 42)), equation 7 and 8 for N—3, equation 9 and 10 for T—1, equation 9 and 11 for T—2, and equation 9 and 12 for T—3 entries, respectively. Asterisks in N—2 show F—values are significant.

(3) BA2 is different from BA1 only by the government employment E8 which is supposed to contain fairly large number of military personnels in San Diego. From this point of view, the statistical significance of the N—2 entry might suggest the economic importance of the military presence. If E8 was incorporated with BA3, the result might have been quite different under this consideration. This case was not estimated, however.

(4) The figures in the parenthesis are t statistics based upon $(Z'Z)^{-1}Z'e$.

(5) To check the plausibility of nonlinear restriction of the form in model (4), model (5) was estimated (shown in table—7), and an F test was made (F (40, 35)) = 2.3602). The result shows the rejection of the form of (4). However, due to the existence of too many insignificant coefficients, and especially of the negative multiplier, this nonrestricted version is hard to interpret. Thus, the model which turned out to be significantly different from the nonrestricted from must be thought of as useful estimation device in terms of calculating multipliers. In fact, when suppressing all of the insignificant variables shown in table—7, table—9 is obtaind. Then, an F test shows that a nonlinear restriction of model (4) is acceptable (F (40, 66) = 0.4694).

(6) The multiplier values less than one imply that the job increase in an industry crowds out job opportunities in other industries. However, the results in the table—6 suggest that Whole Sale and Retail Trade, Services, and the Government sector are big industries for San Diego.

Table-1 LOCATION QUOTIENT 1

E 1	E 2	E 3	E 4	E 5	E 6	E 7	E 8
0.138	1.123	0.699	0.798	1.030	0.914	1.174	1.477
0.143	1.185	0.674	0.814	1.030	0.924	1.179	1.492
0.138	1.044	0.664	0.829	1.053	0.938	1.195	1.504
0.139	1.064	0.637	0.826	1.064	0.943	1.237	1.508
0.143	1.125	0.630	0.829	1.060	0.969	1.208	1.484
0.146	1.165	0.614	0.857	1.063	0.968	1.200	1.502
0.143	0.995	0.616	0.868	1.073	0.982	1.207	1.528
0.180	0.937	0.618	0.835	1.081	1.036	1.219	1.529
0.145	0.844	0.639	0.850	1.082	1.047	1.164	1.518
0.145	1.010	0.640	0.848	1.066	1.049	1.147	1.510
0.142	0.895	0.644	0.864	1.068	1.035	1.147	1.542
0.138	0.913	0.645	0.863	1.072	0.965	1.209	1.506
0.142	0.878	0.674	0.863	1.051	0.961	1.187	1.474
0.143	0.967	0.664	0.798	1.053	0.936	1.173	1.476
0.138	0.877	0.665	0.876	1.060	0.925	1.165	1.492
0.137	0.851	0.627	0.881	1.046	0.881	1.260	1.511
0.138	0.943	0.652	0.869	1.030	0.891	1.216	1.478
0.138	1.043	0.653	0.867	1.026	0.885	1.203	1.462
0.127	0.980	0.655	0.872	1.021	0.888	1.184	1.504
0.123	1.003	0.657	0.852	1.047	0.897	1.183	1.479
0.127	1.056	0.660	0.857	1.032	0.891	1.143	1.502
0.128	1.076	0.651	0.856	1.058	0.871	1.128	1.498
0.122	1.034	0.647	0.868	1.048	0.881	1.137	1.517
0.147	1.085	0.639	0.820	1.059	0.912	1.184	1.481
0.150	1.181	0.654	0.825	1.033	0.915	1.151	1.457
0.152	1.212	0.646	0.842	1.049	0.911	1.150	1.429
0.146	1.118	0.631	0.843	1.050	0.906	1.166	1.454
0.145	1.079	0.622	0.836	1.071	0.909	1.212	1.416
0.147	1.077	0.633	0.843	1.046	0.913	1.184	1.413
0.149	1.176	0.619	0.826	1.056	0.910	1.173	1.408
0.144	1.095	0.600	0.846	1.055	0.912	1.180	1.443
0.143	1.140	0.582	0.838	1.063	0.977	1.186	1.438

LOCATION QUOTIENT 2

E 1	E 2	E 3	E 4	E 5	E 6	E 7	E 8
0.149	1.153	0.554	0.869	1.066	0.990	1.160	1.446
0.148	1.227	0.554	0.855	1.076	0.988	1.148	1.435
0.147	1.271	0.541	0.879	1.070	0.986	1.162	1.480
0.146	1.085	0.536	0.872	1.078	1.002	1.211	1.448
0.145	1.228	0.558	0.852	1.030	1.061	1.179	1.440
0.146	1.172	0.553	0.854	1.050	1.061	1.173	1.443
0.137	1.075	0.557	0.866	1.041	1.065	1.182	1.470
0.136	1.036	0.558	0.856	1.035	1.061	1.207	1.482
0.159	1.130	0.601	0.833	0.988	1.069	1.212	1.428
0.156	1.159	0.601	0.831	1.017	1.048	1.196	1.391
0.150	1.086	0.606	0.849	1.009	1.055	1.186	1.421
0.099	0.891	0.606	0.849	1.017	1.060	1.254	1.410
0.122	0.854	0.653	0.830	1.042	0.999	1.143	1.388
0.113	0.861	0.661	0.827	1.050	0.978	1.129	1.367
0.108	0.934	0.652	0.821	1.042	0.942	1.122	1.385
0.108	0.917	0.627	0.821	1.058	0.995	1.173	1.367
0.108	0.963	0.622	0.814	1.058	1.007	1.120	1.387
0.108	0.995	0.619	0.821	1.062	1.014	1.115	1.381
0.104	0.936	0.615	0.838	1.058	1.019	1.114	1.411
0.103	0.997	0.606	0.833	1.068	1.026	1.133	1.396
0.159	1.279	0.607	0.806	1.034	0.976	1.100	1.397
0.154	1.290	0.601	0.826	1.047	0.985	1.096	1.387
0.148	1.179	0.597	0.840	1.050	0.993	1.103	1.409
0.147	1.191	0.603	0.830	1.052	0.983	1.114	1.401
0.177	1.361	0.617	0.782	1.012	1.030	1.112	1.371
0.176	1.248	0.620	0.795	1.031	1.032	1.121	1.357
0.136	1.216	0.623	0.787	1.032	1.032	1.119	1.375
0.132	1.215	0.623	0.782	1.035	1.022	1.174	1.333
0.109	1.344	0.638	0.756	1.044	1.014	1.166	1.279
0.107	1.302	0.640	0.761	1.059	1.019	1.166	1.268
0.104	1.222	0.661	0.740	1.054	1.006	1.158	1.286
0.101	1.179	0.664	0.733	1.052	1.008	1.173	1.289

LOCATION QUOTIENT 3

E 1	E 2	E 3	E 4	E 5	E 6	E 7	E 8
0.100	1.243	0.700	0.750	1.011	1.062	1.185	1.226
0.098	1.298	0.697	0.765	1.013	1.054	1.174	1.219
0.094	1.111	0.716	0.769	1.002	1.015	1.172	1.255
0.095	1.134	0.717	0.761	1.006	1.018	1.183	1.241
0.052	1.212	0.742	0.753	0.990	1.035	1.165	1.223
0.076	1.243	0.730	0.772	0.992	1.031	1.166	1.222
0.075	1.195	0.723	0.768	0.991	1.022	1.156	1.263
0.073	1.203	0.735	0.775	1.011	1.034	1.177	1.194
0.067	1.132	0.747	0.786	1.030	1.047	1.129	1.213
0.068	1.080	0.757	0.788	0.997	1.057	1.139	1.233
0.061	1.054	0.761	0.794	0.996	1.045	1.143	1.224
0.064	0.992	0.770	0.798	1.003	1.039	1.153	1.198
0.063	0.893	0.773	0.771	1.038	1.043	1.130	1.201
0.067	0.864	0.763	0.791	1.021	1.049	1.138	1.219
0.067	0.870	0.761	0.794	1.031	1.045	1.132	1.218
0.066	0.903	0.766	0.784	1.033	1.039	1.138	1.203
0.064	0.935	0.749	0.783	1.058	1.040	1.117	1.216

Table–2[2)]

	N	T
1	$F(12, 44) = 1.2586$	$F(12, 44) = 1.9193$
2	$F(12, 51) = 4.0432$ *	$F(12, 44) = 1.1614$
	($F(12, 42) = 3.0634$) *	
3	$F(12, 44) = 0.5024$	$F(12, 44) = 1.2358$

Table—3

( ) : t—value

Equation 1		Equation 2			
R^2=0.9964		R^2=0.9965			
RSS=517.149		RSS=384.996			
constant	3.1826	constant	5.2441	BA1(−4)	0.0411
	(1.6063)		(0.7419)		(0.2201)
NBA1(−1)	0.7555	NBA1(−1)	0.6948	BA1(−5)	0.0137
	(5.8754)		(4.3041)		(0.0722)
NBA1(−2)	0.2458	NBA1(−2)	0.2886	BA1(−6)	−0.2157
	(1.4032)		(1.4279)		(−1.0197)
NBA1(−3)	0.1412	NBA1(−3)	0.1359	BA1(−7)	0.0474
	(0.7847)		(0.6455)		(0.2264)
NBA1(−4)	0.4531	NBA1(−4)	0.3013	BA1(−8)	0.0067
	(2.4928)		(1.4123)		(0.0359)
NBA1(−5)	−0.5851	NBA1(−5)	−0.4585	BA1(−9)	0.0530
	(−3.1189)		(−2.1806)		(0.2987)
NBA1(−6)	0.0894	NBA1(−6)	−0.0731	BA1(−10)	0.2414
	(−0.4417)		(−0.3342)		(1.2842)
NBA1(−7)	−0.0480	NBA1(−7)	−0.1338	BA1(−11)	−0.4238
	(−0.2386)		(−0.6143)		(−2.0770)
NBA1(−8)	−0.0480	NBA1(−8)	0.0085	BA1(−12)	0.1582
	(−0.2386)		(0.0406)		(1.2047)
NBA1(−9)	0.0045	NBA1(−9)	0.0667		
	(0.0242)		(0.3128)		
NBA1(−10)	−0.0932	NBA1(−10)	−0.0148		
	(−0.4357)		(−0.0599)		
NBA1(−11)	0.1989	NBA1(−11)	0.0627		
	(−0.9373)		(0.2351)		
NBA1(−12)	0.3673	NBA1(−12)	0.0963		
	(2.3306)		(0.4698)		
		BA1(−1)	−0.0238		
			(−0.1757)		
		BA1(−2)	0.1852		
			(0.8898)		
		BA1(−3)	−0.0688		
			(−0.3553)		

(Table−3 continued)

Equation 3		Equation 4			
R^2=0.9951		R^2=0.9961			
RSS=364.136		RSS=186.608			
Constant	1.6383	Constant	0.6041	BA2(−11)	−0.1166
	(1.5570)		(0.3595)		(−1.4025)
NBA2(−1)	1.0541	NBA2(−1)	0.8830	BA2(−12)	0.1179
	(10.0141)		(5.8878)		(2.0092)
NBA2(−2)	0.0371	NBA2(−2)	0.2089		
	(0.2383)		(1.0193)		
NBA2(−3)	−0.0904	NBA2(−3)	0.1018		
	(−0.5827)		(0.4883)		
NBA2(−4)	0.4613	NBA2(−4)	−0.1543		
	(2.9363)		(−0.7534)		
NBA2(−5)	−0.4708	NBA2(−5)	−0.1141		
	(−4.3923)		(−0.7464)		
		BA2(−1)	0.0517		
			(0.8641)		
		BA2(−2)	0.0278		
			(0.3470)		
		BA2(−3)	−0.0193		
			(−0.2392)		
		BA2(−4)	0.1537		
			(1.9097)		
		BA2(−5)	−0.2577		
			(−2.9233)		
		BA2(−6)	−0.0614		
			(−0.6161)		
		BA2(−7)	0.0525		
			(0.5242)		
		BA2(−8)	0.0846		
			(0.9262)		
		BA2(−9)	0.0910		
			(1.0441)		
		BA2(−10)	−0.0972		
			(−1.1448)		

(Table−3 continued)

Equation 5

R^2=0.9940
RSS=302.254

Constant	0.0553
	(0.0401)
NBA2(−1)	0.9871
	(7.1887)
NBA2(−2)	0.9871
	(0.8694)
NBA2(−3)	0.0510
	(−0.2595)
NBA2(−4)	0.4209
	(2.1055)
NBA2(−5)	−0.5610
	(−2.6994)
NBA2(−6)	−0.1257
	(−0.5657)
NBA2(−7)	0.0287
	(0.1289)
NBA2(−8)	0.0328
	(0.1476)
NBA2(−9)	0.0292
	(0.1384)
NBA2(−10)	−0.0411
	(−0.1997)
NBA2(−11)	0.0358
	(0.1726)
NBA2(−12)	0.1196
	(0.5855)
NBA2(−13)	−0.0350
	(−0.2308)

Equation 6

R^2=0.9959
RSS=161.180

Constant	−0.6932
	(−0.2977)
NBA2(−1)	0.9180
	(5.5988)
NBA2(−2)	0.1667
	(0.7610)
NBA2(−3)	0.1558
	(0.7007)
NBA2(−4)	−0.1502
	(−0.6686)
NBA2(−5)	−0.1939
	(−0.9176)
NBA2(−6)	0.0090
	(0.0420)
NBA2(−7)	0.0708
	(0.3353)
NBA2(−8)	−0.2480
	(−1.2006)
NBA2(−9)	0.1389
	(0.6950)
NBA2(−10)	0.0164
	(0.0829)
NBA2(−11)	0.2985
	(1.4811)
NBA2(−12)	−0.2428
	(−1.2224)
NBA2(−13)	0.0259
	(0.1878)
BA2(−1)	0.0216
	(0.3348)
BA2(−2)	0.0547
	(0.6409)
BA2(−3)	−0.0076
	(−0.0889)
BA2(−4)	0.1601
	(1.8563)
BA2(−5)	−0.2493
	(−2.5835)
BA2(−6)	−0.0934
	(−0.8624)
BA2(−7)	0.0523
	(0.4803)
BA2(−8)	0.1237
	(1.1827)
BA2(−9)	0.0982
	(0.9439)
BA2(−10)	−0.0359
	(−0.8004)
BA2(−11)	−0.2348
	(−2.2306)
BA2(−12)	0.1761
	(2.2020)

(Table−3 continued)

Equation 7

$R^2=0.9977$
RSS=1213.45

Constant	4.1540	(1.6341)
NBA3(−1)	0.9967	(8.0483)
NBA3(−2)	0.1460	(0.8038)
NBA3(−3)	−0.1647	(−0.9015)
NBA3(−4)	0.6604	(3.5831)
NBA3(−5)	−0.8546	(−4.2018)
NBA3(−6)	0.0515	(−4.2018)
NBA3(−7)	0.3399	(1.4723)
NBA3(−8)	−0.2259	(−1.0898)
NBA3(−9)	0.0800	(0.4203)
NBA3(10)	−0.1069	(−0.5561)
NBA3(−11)	−0.3316	(−1.7223)
NBA3(−12)	0.4100	(3.0664)

Equation 8

$R^2=0.9974$
RSS=1067.22

Constant	4.4653	(1.0410)
NBA3(−1)	0.9508	(6.3370)
NBA3(−2)	0.1534	(0.7468)
NBA3(−3)	−0.1937	(−0.9370)
NBA3(−4)	0.7563	(3.6296)
NBA3(−5)	−0.8507	(−3.6317)
NBA3(−6)	0.0805	(0.3044)
NBA3(−7)	0.3042	(1.1367)
NBA3(−8)	−0.1411	(−0.5685)
NBA3(−9)	0.1136	(0.4541)
NBA3(10)	−0.1637	(−0.6308)
NBA3(−11)	−0.4661	(−1.8078)
NBA3(−12)	0.4751	(2.5135)
BA3(−1)	0.1105	(0.2716)
BA3(−2)	−0.2410	(−0.4417)
BA3(−3)	0.5382	(0.9855)
BA3(−4)	−0.7746	(−1.4100)
BA3(−5)	0.0496	(0.0941)
BA3(−6)	0.1268	(0.2382)
BA3(−7)	−0.0544	(−0.1043)
BA3(−8)	−0.0781	(−0.1555)
BA3(−9)	0.0985	(0.1994)
BA3(−10)	0.1942	(0.3936)
BA3(−11)	0.1368	(0.2731)
BA3(−12)	−0.1734	(−0.4626)

(Table–3 continued)

Equation 9		Equation 10			
R^2=0.9977		R^2=0.9981			
RSS=1920.64		RSS=1260.73			
Constant	3.6735	Constant	−12.0968	BA1(−4)	−0.1406
	(1.1937)		(−0.9408)		(−0.2292)
E(−1)	0.9937	E(−1)	0.3868	BA1(−5)	0.0878
	(7.7397)		(1.3180)		(0.1520)
E(−2)	0.1904	E(−2)	0.8340	BA1(−6)	0.3771
	(1.0108)		(2.2668)		(0.6379)
E(−3)	−0.1160	E(−3)	0.1358	BA1(−7)	0.1166
	(−0.6101)		(0.3526)		(0.1964)
E(−4)	0.6030	E(−4)	0.7196	BA1(−8)	0.2982
	(3.1396)		(1.8480)		(0.5323)
E(−5)	−0.8890	E(−5)	−0.8558	BA1(−9)	0.2826
	(−4.2603)		(−2.2264)		(0.5061)
E(−6)	0.0341	E(−6)	−0.2880	BA1(−10)	−1.1719
	(−0.1418)		(−0.7197)		(−1.8409)
E(−7)	0.2861	E(−7)	−0.0422	BA1(−11)	0.7164
	(1.1887)		(−0.1058)		(0.9802)
E(−8)	−0.1079	E(−8)	−0.4973	BA1(−12)	−0.5729
	(−0.5045)		(−1.3051)		(−1.0942)
E(−9)	0.1291	E(−9)	0.2308		
	(0.6514)		(0.5908)		
E(−10)	−0.0800	E(−10)	0.7686		
	(−0.3990)		(1.6937)		
E(−11)	−0.3172	E(−11)	−0.6465		
	(−1.5959)		(−1.3120)		
E(−12)	0.3453	E(−12)	0.5016		
	(2.4587)		(1.3295)		
		BA1(−1)	0.9128		
			(2.0242)		
		BA1(−2)	−1.1450		
			(−1.8196)		
		BA1(−3)	−0.1886		
			(−0.3053)		

(Table−3 continued)

Equation 11

R^2=0.9978
RSS=1458.63

Constant	5.0058	(0.7539)
E1(−1)	1.1553	(2.4019)
E1(−2)	−0.2180	(−0.3312)
E1(−3)	0.4941	(0.7461)
E1(−4)	−0.7718	(−1.1765)
E1(−5)	−0.0300	(−0.0473)
E1(−6)	0.2465	(0.3825)
E1(−7)	−0.0949	(−0.1506)
E1(−8)	−0.4626	(−0.7725)
E1(−9)	0.3438	(0.5808)
E1(−10)	0.1301	(0.2200)
E1(−11)	0.3761	(0.6229)
E1(−12)	−0.2855	(−0.6358)
BA2(−1)	−0.2454	(−0.4222)
BA2(−2)	0.4795	(0.6220)
BA2(−3)	−0.6707	(−0.8649)
BA2(−4)	1.6671	(2.1618)
BA2(−5)	−1.0490	(−1.3608)
BA2(−6)	−0.2867	(−0.3624)
BA2(−7)	0.5006	(0.6440)
BA2(−8)	0.4835	(0.6346)
BA2(−9)	−0.2358	(−0.3041)
BA2(−10)	−0.3943	(−0.5070)
BA2(−11)	−1.0110	(−1.2738)
BA2(−12)	0.9216	(1.5423)

Equation 12

R^2=0.9978
RSS=1436.49

Constant	2.9611	(0.5944)
E1(−1)	0.9689	(5.5562)
E1(−2)	0.2262	(0.9534)
E1(−3)	−0.2296	(−0.9607)
E1(−4)	0.8990	(3.7270)
E1(−5)	−1.0494	(−3.8733)
E1(−6)	−0.0463	(−0.1519)
E1(−7)	0.3906	(1.2672)
E1(−8)	−0.0527	(−0.1837)
E1(−9)	0.2206	(0.7613)
E1(−10)	−0.2343	(−0.7807)
E1(−11)	−0.7204	(−2.4232)
E1(−12)	0.6579	(2.9972)
BA3(−1)	0.0440	(0.0788)
BA3(−2)	−0.3124	(−0.4264)
BA3(−3)	0.9366	(1.2792)

(Table–3 continued)

BA3(−4)	−1.7572	BA3(−7)	−0.4412	BA3(−10)	0.4202
	(−2.3828)		(−0.6028)		(0.5649)
BA3(−5)	0.8544	BA3(−8)	−0.2836	BA3(−11)	1.1857
	(1.1688)		(−0.3927)		(1.5705)
BA3(−6)	0.2275	BA3(−9)	0.0533	BA3(−12)	−1.0508
	(0.3062)		(0.0726)		(−1.8392)

Table－4

$R^2=0.9979$

a(1) =	7.7112	a(8) =	1.2519
	(0.8110)		(6.6217)
a(2) =	0.7505	w(1) =	1.0
	(2.8167)		
a(3) =	.7817	w(2) =	−0.0920
	(4.2115)		(−1.0127)
a(4) =	0.8750	w(3) =	−0.1145
	(0.7532)		(−1.1616)
a(5) =	1.2993	w(4) =	0.6439
	(5.4052)		(6.3854)
a(6) =	1.5200	w(5) =	−0.6778
	(1.8356)		(−7.6318)
a(7) =	1.6828		
	(4.6436)		

Table-5

1	5.8574	5	0.9869
2	0.5701	6	1.1546
3	0.5938	7	1.2783
4	0.6647	8	0.9509

Table-6[6)]

2	0.7251	7	1.6258
3	0.7552	8	1.2095
5	1.2552		

Table-7

$R^2=0.9989$

RSS=672.766

Constant	13.2868	E4(−2)	−3.1737	E7(−4)	0.2455
	(0.5764)		(−1.3146)		(0.4474)
E1(−1)	15.3615	E4(−3)	−1.2787	E7(−5)	−0.1482
	(1.2522)		(−0.5573)		(−0.2828)
E1(−2)	4.1035	E4(−4)	0.7820	E8(−1)	−0.2709
	(0.3246)		(0.3161)	E9(−2)	1.3268
E1(−3)	−3.0238	E4(−5)	−0.3105		(3.0150)
	(−0.2350)		(−0.1544)	E8(−3)	0.3362
E1(−4)	19.3542	E5(−1)	0.9313		(0.7669)
	(1.4269)		(2.2919)	E8(−4)	1.0499
E1(−5)	0.6130	E5(−2)	0.3656		(2.5708)
	(−0.0416)		(0.8329)	E8(−5)	−1.5731
E2(−1)	1.5394	E5(−3)	0.0744		(−3.8143)
	(3.3692)		(0.1732)		
E2(−2)	−1.0823	E5(−4)	−0.3508		
	(−1.8201)		(−0.8383)		
E2(−3)	0.5779	E5(−5)	0.1057		
	(−0.9427)		(0.3162)		
E2(−4)	1.2797	E6(−1)	−1.8233		
	(2.0626)		(−1.0974)		
E2(−5)	−0.8864	E6(−2)	3.3071		
	(−1.7509)		(1.7196)		
E3(−1)	1.1388	E6(−3)	−2.6547		
	(2.2743)		(−1.3591)		
E3(−2)	−0.2857	E6(−4)	2.4465		
	(−0.4001)		(1.2101)		
E3(−3)	0.7763	E6(−5)	−1.7253		
	(1.0720)		(−1.0631)		
E3(−4)	−1.4135	E7(−1)	1.2909		
	(−1.9301)		(2.1789)		
E3(−5)	0.3687	E7(−2)	−0.2746		
	(0.7167)		(−0.4933)		
E4(−1)	4.8071	E7(−3)	0.5252		
	(2.4378)		(0.8706)		

Table-8

1	35.1824	5	1.1262
2	0.2726	6	-0.4498
3	0.5846	7	1.6388
4	0.8262	8	0.8690

Table-9

$R^2 = 0.9984$

RSS＝1936.56

Constant	14.8733	E5(−1)	1.2303
	(1.2281)		(4.8753)
E2(−1)	1.2000	E7(−1)	1.2981
	(5.2354)		(6.2595)
E2(−4)	−0.0344	E8(−2)	1.9990
	(−0.1440)		(8.4625)
E3(−1)	0.6814	E8(−4)	0.4893
	(4.6138)		(1.8912)
E4(−1)	0.0026	E8(−5)	−1.4623
	(0.0024)		(−5.4469)

References

〔1〕 M. C. Daly, "An Approximation to a Geographical Multiplier", Economic Journal (Sep., 1940), pp248—58.

〔2〕 C. W. J. Granger,"Investigating Causal Relations by Econometric Models and Cross-Spectral Methods" Econometrica (July 1969), pp424—38.

〔3〕 J. Heilbrun, Urban Economics and public policy (St. Martin's Press, Inc. 1981)[chap. 1, 2, 3, 7].

〔4〕 G. H. Hildebrand, A. Mace Jr, "The Employment Multiplier in an expanding Industrial Market: Los Angels County 1940—47" Review of Economics and Statistics (Aug., 1950), pp241—49.

〔5〕 H. Hoyt "Homer Hoyt on Development of Economic Base Concept", Land Economics, (May, 1954), pp182—86.

〔6〕 D. C. North, "Location Theory and Regional Economic Growth" in D. L. Mckee, R. D. Dean, W. H. Leahy (edit.), Regional Economics: Theory and Practice (The Free Press, 1970).

〔7〕 R. W. Pfouts, E. T. Curtis, "Limitations of the Economic Base Analysis", Social Forces, (36, 1958), pp303—10.

〔8〕 H. W. Richardson, Regional Growth Theory (John Wiley and Sons, 1973) [chap. 2].

〔9〕 E. F. Terry, "Linear Estimators of the Export Employment Multiplier", Journal of Regional Science, (Summer 1965), pp17—34.

〔10〕 S. J. Weiss, E. C. Gooding, "Estimation of Differential Employment Multipliers in a Small Regional Economy", Land Economics, (May 1968), pp235—244.