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DEFENSE EXPENDITURES IN FORECASTS OF CALIFORNIA'S ECONOMIC GROWTH

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The purpose of this paper is to demonstrate one of the policy-informing uses of an econometric forecasting model developed for the State of California.

At the outset, let us make clear that our interests in the regional impact of defense expenditures on California is somewhat peripheral. There are at least two reasons why this is so. First, a number of students of economics are engaged in estimating the impact of possible defense cutbacks on the California economy.¹ Thus far, there is rough agreement on the order of effects to be expected, though there are basic differences in the methods used to calculate these effects. While these estimates of the defense-spending impact on California have all had serious deficiencies, they have provided some evidence to settle the questions now stirring California government and business decision-makers — the requirements of policy do not yet require more refined answers.

Second, and more important, we are concerned chiefly with the task of constructing a reliable econometric forecasting model of the California economy. To date we have not succeeded in bringing the full potential of this model to bear

¹For example, there are the works by Richard Peterson and Charles Tiebout, "Defense-Space Expenditures: Their Local and Spatial Repercussions," presented at the American Economic Association and Regional Science meeting in Boston, December 1963; and "An Economic Analysis of Local and Regional Impacts of Reduction of Military Expenditures," by Walter Isard and Eugene Schooler, presented at the Peace Research Conference, University of Chicago, November 1963.

upon specific policy or industry impact questions. We expect to conduct such elaborations, as well as a number of improvements in the basic model itself, as part of the second phase of the State Development Plan, at the Center for Planning and Development Research, University of California at Berkeley, during 1964-1965. The report made in this paper must be viewed as a highly tentative manipulation of this version of the forecasting model. Indeed, it should be remembered that use of this model for measuring the repercussions of changes in demand is, at this stage, secondary to its use in forecasting, though the two uses are necessarily related. The advantages and limitations of the model will be suggested by the following skeletal description of it.

THE BASIC ECONOMETRIC MODEL

The State Office of Planning, which is preparing a development plan for the State of California with the assistance of a 701 grant from the Housing and Home Finance Agency, commissioned the construction of the economic model which we are making use of in this paper. The principal assignment, which was carried out under contract with the Arthur D. Little Company, called for the forecasting of personal income in the State of California, by major industry groups, etc. This research was conducted by a team headed by John Dyckman. Richard Burton was in charge of the construction of the model with consulting assistance from Roland Artle, Charles Tiebout, David Houston, Charles Leven and others. The forecasting model that emerged is based on a quarterly time-series analysis of intersectoral flows in the California economy. Time-series data for the analysis were provided by the Department of Employment, Department of Finance, and Department of Industrial Relations of the state. Basic data were the wages and salaries and nonwage income series for the forty quarters extending from the second quarter, 1950, through the first quarter, 1960, supplemented by data from the U.S. Department of Commerce, the California State Chamber of Commerce, the National Planning Association and various special studies. Some 53 industry groups, including seven partitions of the retail trade sector and four of the government, were used to exhaust the two- and three-digit SIC classifications. The output of the model was a forecast of wages and salaries, generated in each of these 53 industries, and nonwage income, quarterly, for the years 1960 to 1975.

A distinctive aspect of the model's framework is the use of current economic base theory. That is, it recognizes three main types of aggregate market demand: interindustry demand, local final demand, and export demand. The sectoring of demand is important for the emphasis it places on the role of exports as a generator of regional economic growth.

Using wages and salaries as a proxy variable for output, we were able to estimate the pattern of trade flows in each of the industry's demand sectors by use of least-squares multiple regression analysis. Explanation of the flows is inferred from correlative changes in the wages and salaries of linked industries. Our knowledge concerning the trade patterns was based largely on the reweight-

ing of materials developed in the California markets study for the State Economic Development Agency in 1960.²

In order to satisfy the unilateral causation requirement of the regression model, the interindustry equations are set in a triangular array. Omitting dummy (seasonal) variables,³ interindustry linkages are estimated:

$$(1) \quad W_{iN} = a_i + \sum_{j=1}^n b_{ij} W_j + u_i$$

Where W_{iN} = either all, or that part of, any i^{th} industry's wages and salaries generated by interindustry demand,

and W_j = total wages and salaries in any j^{th} (receiving) industry.

An example of a selected interindustry equation found in the model is that of the tin can industry (SIC 341):

$$(1a) \quad \bar{W}_{TC, N} = -995.8 + .042 (\text{canning and preserving}) + .307 (\text{chemicals and allied products})$$

An industry's local final demand sector (W_{iD}) which may include the consumption, investment and government equations (excluding the federal military) is specified, in general, as:

$$(2) \quad W_{iD} = a_i + b_i \left(\sum_{i=1}^{53} W_i \right) + u_i$$

Where W_{iD} = either all, or that part of, any i^{th} industry's wages and salaries generated by local final demand,

and $\sum_{i=1}^{53} W_i$ = total wages and salaries in all California industries.

A local final-demand equation is illustrated in the case of retail trade-food (SIC 54):

$$(2a) \quad \bar{W}_{RTF, D} = 1902.5 + .016 \left(\sum_{i=1}^{53} W_i \right) + .006 (\text{nonwage income})$$

² W. L. Hansen, R. Thayne Robson, and C. M. Tiebout, *Markets for California Products* (California Economic Development Agency, 1961). See also W. L. Hansen and C. M. Tiebout, "An Inter-sectoral Flows Analysis of the California Economy," *Review of Economic Statistics*, November 1963, pp. 409-18.

³ A number of seasonal variables — both intercept and interaction — were employed which provided the means of handling the usual problem of seasonal variation on a parametric basis. Our technique in this case was largely based upon that used in Klein and others, *An Econometric Model of the United Kingdom*, University Institute of Statistics, Monograph No. 6 (Oxford, 1961).

A related issue — serial correlation in disturbance terms — required the transformation of many variables into first difference form. The use of first differences serves to eliminate a major source of variation in economic time-series data, the variation contributed by linear trend.

Finally, export demand (W_{ix}) reflects either all or that increment of any i^{th} industry's wages and salaries generated by demand originating outside the State of California, including the federal government. Exports have been defined as functions of the following predetermined national variables: consumer non-durables (CND), consumer durables (CD), services (Serv), plant investment (PI), equipment investment (EI), residential investment (RI), defense expenditures (Def), and total Gross National Product (GNP).

Hence:

$$(3) \quad W_{ix} = a_i + b_i(CND, CD, Serv, PI, EI, RI, Def, GNP) + u_i$$

The forecast values of these predetermined national variables are taken from the National Planning Association's economic projections.⁴

Our aircraft-ordnance (SIC 372-19) industry equation provides a good illustration of (3) above:

$$(3a) \quad \bar{W}_{A-o, x} = -515310.6 + .075(Def) + .024(EI) \\ (.007) \quad (.007)$$

The equipment investment (EI) variable indicates export shipments of ordnance and aircraft and parts to the private sector.

Total wages and salaries in the California economy are then accounted for in the following identity:

$$(4) \quad \sum W_i = \sum W_{IN} + \sum W_{ID} + \sum W_{IX}$$

A specification of the structure of the economy (apart from the necessary identities) required 91 equations, of which 90 were wage and salary equations and one was a nonwage income equation. In addition to the use of wage and salary payments of individual industries, total California wage and salary payments, selected national variables, and a number of seasonal variables were employed. The solution of the 91 simultaneous equations not only accounted for the structural interrelationships in the economy of the state, but also achieved highly reliable individual industry and total industry forecasts. The forecast results of aggregate wages and salaries (given *actual* exogenous values) are shown in Table 1.

Before proceeding directly with the defense impact analysis at least one word of caution should also be noted. Our use of a stepwise regression program which called for high (95 per cent) confidence requirements had the effect of eliminating from the equations many explanatory variables which otherwise would have been expected to be influential. In the first phase of this work, we sacrificed this additional structural detail for the sake of improved accuracy in forecasting, to meet the forecasting requirements of the development plan. With less stringent limits, and some relaxation of forecasting precision, considerable enrichment might be added to the model. This additional detail would be desirable in repertory analysis and might well be included in other uses of the model.

⁴National Planning Association, *National Economic Projections*, Series 1962.

TABLE 1

FORECASTED VS. ACTUAL TOTAL WAGES AND SALARIES
STATE OF CALIFORNIA, SECOND QUARTER 1960-FOURTH QUARTER 1962

		Forecasted wages and salaries (thousands of dollars)	Actual wages and salaries (thousands of dollars)	Percentage deviation
1960	Second	6,925,299	6,957,542	-.46
	Third	7,024,700	7,227,875	-2.81
	Fourth	7,294,364	7,358,915	-.88
1961	First	6,969,951	7,043,066	-1.04
	Second	7,285,216	7,296,205	-.15
	Third	7,524,894	7,527,716	-.04
	Fourth	7,917,060	7,871,635	+.58
1962	First	7,619,911	7,623,730	-.05
	Second	7,890,016	7,916,553	-.34
	Third	7,992,232	8,127,207	-1.69
	Fourth	8,470,490	8,422,985	+.56

THE IMPACT OF A SELECTED REDUCTION IN DEFENSE EXPENDITURE
ON THE CALIFORNIA ECONOMY

The detailed nature of this forecasting model suggested a number of planning uses. Since the California economy has developed with the massive assistance of federal demand for military and space goods in the decade of the 1950's, there has been an understandable interest in the potential impact on the economy of a reduction in that demand. The uncertainties in defense procurement reflected in the dependence of defense spending on international political circumstances and the uncertain nature of military technology and defense needs help to create conditions of vulnerability to serious economic upheaval for California industry. As a result, there is substantial interest in the state in estimating the probable impact of alternative federal military and space procurement programs. For example, the California Department of Finance would like to know the impact of a change (reduction) in U.S. defense outlays on the total wage and salary bill in California and, of greater importance, how this impact distributes itself over the various (53) industrial sectors. In the first phase of the California State Development Plan we have given some attention to calculating this impact, though we have not yet conducted a complete analysis of the problem — if such, indeed, is possible.

As a first step, it is necessary to define "defense spending" as it relates to this framework. We have defined national defense spending as being virtually equiva-

lent to the category "major national security" in the Department of Commerce series. Thus, defense spending includes military and nonmilitary national defense outlays.

A reduction of defense spending can take many forms: a change in the mix in Department of Defense and other procurements, as well as a change in the spatial distribution of defense expenditures which falls unevenly on different areas. We have chosen to focus on over-all reductions, rather than changes in composition of expenditures or geographical distribution of contracts, because this model does not presently account for such shifts. There are two major reasons for this limitation: the paucity of *available* historical data, and the difficulty in forecasting shifts which depend in large measure on (autonomous) political determination. In the illustrative case presented here, no assumptions about such shifts were required.

The impact of a selected reduction in defense spending, according to the present model, would be felt initially on those industries whose export equations contain defense spending as a significant *exogenous* variable and, secondly, on the induced changes in the values of the *endogenous* variables.⁵

In order to test the impact of given changes, the level of defense expenditures in a selected year, 1961, was reduced by 10 per cent and 25 per cent in turn. The impact on the California economy of the 10 per cent reduction can be illustrated by the following calculations. (Since the model is a linear one, a 25 per cent reduction produces virtually the same impact multipliers.)

National defense spending in 1961 was \$49 billion. A reduction of 10 per cent, or \$4.9 billion, was assumed to decrease Gross National Product by a corresponding amount (neither compensatory spending nor multiplier effects were postulated), from \$520.4 billion to \$515.5 billion. As a result of the reduced level of GNP, the number of export equations affected by the change was increased by 11 (those equations in which GNP appears as a significant explanatory variable), adding to a total of 19 directly "impacted" industries. Furthermore, once the values of the appropriate predetermined variables were reduced by the amount of the cutback, the model had to be rerun, utilizing the new defense-GNP values.

Thus far, we have measured the impact in two ways: (1) what is the impact on total California wages and salaries of a one-dollar reduction in wages and salaries of industries exporting directly to national defense, and, closely related, (2) what is the impact on total California wages and salaries of a one-dollar reduction in U.S. national defense-GNP expenditures?

The impact multiplier effect of changes in U.S. defense demand is determined by the demand variables of the respective forecasting equations. A solution of the equations with the reduced values of national defense and GNP expenditure shows that a reduction of \$1 in exports of the impacted defense industries (the 19 mentioned above) results in a \$2.47 reduction in total wages and salaries in California. Thus, the value of this impact multiplier may be said to be 2.47.

⁵ For a technical discussion of "reduced form" impact multipliers, see A. S. Goldberger, *Impact Multipliers and Dynamic Properties of the Klein-Goldberger Model* (Amsterdam: North-Holland Publishing Co., 1959), ch. III.

From another perspective, that of (2) above, a one-dollar decrease in U.S. defense expenditures results in a reduction of \$0.23 in total wages and salaries in California.

Table 2 shows the calculated values of defense exports and total California wages and salaries for each quarter and for the year 1961 under the conditions of actual expenditure and the level resulting from 10 per cent reduction of defense-GNP expenditure.

TABLE 2
IMPACT ON CALIFORNIA WAGES AND SALARIES OF A TEN PER CENT
REDUCTION IN DEFENSE EXPENDITURES

1961	Wages and salaries	Actual (millions of dollars)	10 per cent reduction (millions of dollars)	Change	Impact multiplier
First Quarter	Exports-defense	1,046.1	930.8	-115.3	2.428
	Total wages and salaries	6,969.9	6,690.0	-279.9	
Second Quarter	Exports-defense	1,151.9	1,036.6	-115.3	2.421
	Total wages and salaries	7,285.2	7,006.0	-279.2	
Third Quarter	Exports-defense	1,203.6	1,088.2	-115.4	2.443
	Total wages and salaries	7,524.8	7,242.9	-281.9	
Fourth Quarter	Exports-defense	1,253.7	1,128.8	-124.9	2.449
	Total wages and salaries	7,917.0	7,611.1	-305.9	
Annual	Exports-defense	4,655.3	4,184.5	-470.8	2.436
	Total wages and salaries	29,696.9	28,550.0	-1,146.9	

The impact on individual industries under the more dramatic 25 per cent reduction condition is shown in Table 3. Note that the combined aircraft-ordnance and government-military sectors account for about 95 per cent of the *direct* (export) impact. Aircraft-ordnance, as might be expected, is the most

affected industry by far. Its substantial role in the California economy, particularly in the share of exports, is underlined by our computations. Under the 25 per cent reduction condition, almost a billion dollars of wages and salaries are lost to this industry alone. The percentage impacts for all 53 industries are shown below:

TABLE 3
IMPACT ON CALIFORNIA INDUSTRIES OF A TWENTY-FIVE PER CENT
REDUCTION IN DEFENSE EXPENDITURES

Industry number	Industry	Actual (millions of dollars)	25 per cent reduction (millions of dollars)	Change	Percentage change
1	Public utilities	320.8	300.3	-20.5	-6.4
2	Crude petroleum	161.5	159.9	-1.6	-1.0
3	Mining	71.6	66.1	-5.5	-7.7
4	Rubber and plastics	90.6	83.4	-7.2	-7.9
5	Pulp and papermills	35.6	33.6	-2.0	-5.6
6	Paper and allied products	143.0	132.9	-10.1	-7.1
7	Commercial printing	155.3	144.0	-11.3	-7.3
8	Business services	750.9	665.2	-85.7	-11.4
9	Primary metals	348.8	309.2	-39.6	-11.3
10	Tin cans	59.0	55.0	-4.0	-6.8
11	Tires and tubes	60.8	47.9	-12.9	-21.2
12	Printing and publishing	295.2	277.7	-17.5	-5.9
13	Petroleum refining	263.0	252.5	-10.5	-4.0
14	Transportation and communication	1977.8	1880.9	-96.9	-4.9
15	Finance and insurance	1058.3	975.8	-82.5	-7.8
16	Grain mill and miscellaneous foods	138.2	127.5	-10.7	-7.7
17	Logging and sawmills	210.4	194.2	-16.2	-7.7
18	Industrial chemicals	116.6	108.4	-8.2	-7.0
19	Stone, clay, and glass	265.4	242.2	-23.2	-8.7
20	Chemicals and allied products	164.3	151.4	-12.9	-7.8
21	Lumber and wood products	125.5	112.5	-13.0	-10.3
22	Agriculture, forestry, and fisheries	634.8	617.7	-17.1	-2.7
23	Wholesale trade	1910.5	1810.4	-100.1	-5.2
24	Instruments	163.2	153.1	-10.1	-6.2

TABLE 3 (continued)

Industry number	Industry	Actual (millions of dollars)	25 per cent reduction (millions of dollars)	Change	Percentage change
25	Office furniture	56.9	52.4	-4.5	-7.9
26	Sugar	28.2	27.9	-.3	-1.1
27	Meat and dairy	274.7	258.8	-15.9	-5.8
28	Canning and preserving	244.4	244.4	—	—
29	Tobacco and assorted foods	275.3	263.4	-11.9	-4.3
30	Fabricated metals	554.4	472.3	-82.1	-14.8
31	Textile — leather	52.6	57.7	+5.1	+9.7
32	Electrical machinery	1042.7	924.3	-118.4	-11.4
33	Miscellaneous manufacturing	103.8	87.9	-15.9	-15.3
34	Apparel	225.9	217.2	-8.7	-3.8
35	Transportation equipment	286.3	246.6	-39.7	-13.9
36	Household furniture	129.6	115.1	-14.5	-11.2
37	Nonelectrical machinery	588.6	536.9	-51.7	-8.8
38	Aircraft-ordnance	2214.0	1293.2	-920.8	-41.6
39	Personal services	2188.5	2031.7	-156.8	-7.2
40	Heavy construction	522.5	464.2	-58.3	-11.2
41	General construction	1638.2	1392.7	-245.5	-15.0
42	Retail trade — lumber and furniture	464.0	390.0	-74.0	-15.9
43	Retail trade — G.M. and miscellaneous	838.3	771.8	-66.5	-7.9
44	Retail trade — food	595.1	556.5	-38.6	-6.5
45	Retail trade — auto	463.3	427.8	-35.5	-7.7
46	Retail trade — gas	185.1	176.1	-9.0	-4.9
47	Retail trade — apparel	206.0	191.9	-14.1	-6.8
48	Retail trade — eating and drinking	538.6	514.5	-24.1	-4.5
49	Real estate	168.6	156.2	-12.4	-7.3
50	Government — federal civilian	1501.6	1385.2	-116.4	-7.7
51	Government — federal military	1289.2	1085.6	-203.6	-15.8
52	Government — state	816.0	828.4	+12.4	+ .2
53	Government — local	2683.5	2746.1	+62.6	+ 2.3
	TOTAL	29,696.9	26,816.6	-2,880.3	-9.7