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A GENERAL EQUILIBRIUM ANALYSIS

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Abstract

Reductions in federal defense expenditure are studied with a general equilibrium simulation model. The experimental scenarios for spending cuts include reductions due to cost sharing within strategic alliances and unilateral disarmament. In both cases, the economic effects of one-time only cuts and sustained reductions over time are evaluated. When one-time cuts are undertaken, significant changes in the composition of national income and product are observed. In the case of sustained reductions in defense spending, the resulting increased private saving and capital formation led to substantial increases in real GNP.

The Opportunity Cost of Defense Spending: A General Equilibrium Analysis

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ABSTRACT

Reductions in federal defense expenditure are studied with a general equilibrium simulation model. The experimental scenarios for spending cuts include reductions due to cost sharing within strategic alliances and unilateral disarmament. In both cases, the economic effects of one-time only cuts and sustained reductions over time are evaluated. When one-time cuts are undertaken, significant changes in the composition of national income and product are observed. In the case of sustained reductions in defense spending, the resulting increased private saving and capital formation led to substantial increases in real GNP.

1. Introduction

Defense expenditures are a large and, recently, a growing share of government spending in the United States. Since World War II, these expenditures have never been less than 60% of federal government purchases of goods and services (Figure 1). In the last decade, these expenditures have risen sharply, exceeding 75% of real federal expenditure in 1986 (Figure 2). The economic implications of a large commitment to military spending have come under increased scrutiny in recent years. Quite apart from the purely macroeconomic issues of large increases in deficit spending in recent years, some

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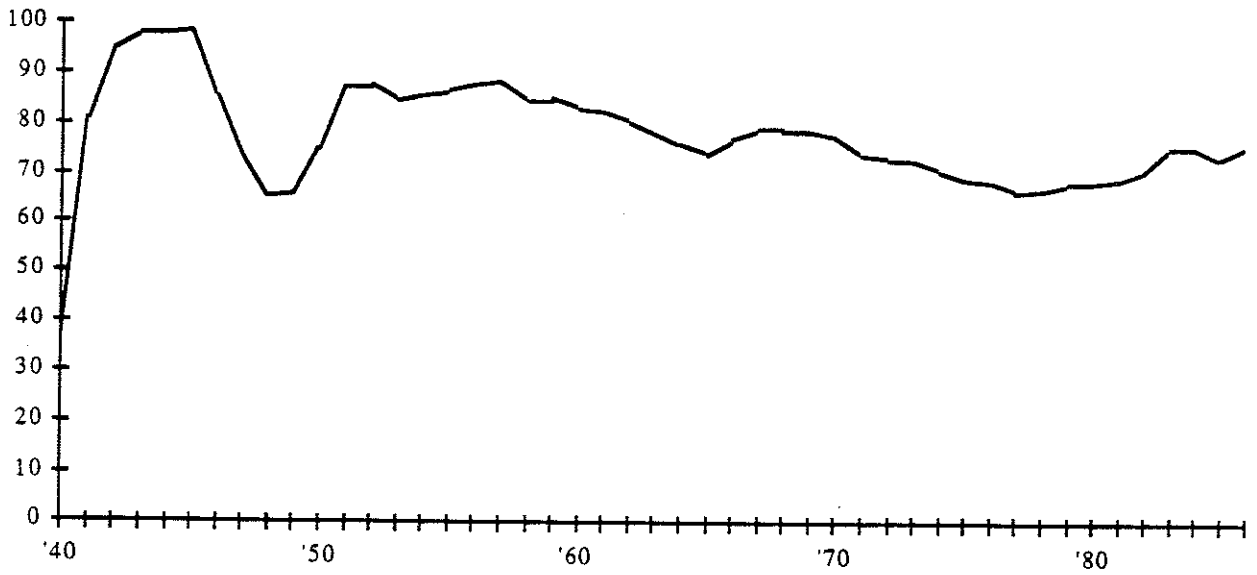
authors have argued that increasing real military expenditures may lead to the long-term decline of the U.S. economy.¹ Deficit financing of military budgets represents an implicit diversion of domestic and foreign financial capital to nonproductive investment. The opportunity cost of this diversion, especially in a country with low savings rates, may be quite high.

From an economist's viewpoint, defense expenditure involves of the purchase of a public good, "military security." How much of such a public good to provide is inherently a political issue, and thus lies largely outside our purview. What economics can offer, however, is an analysis of the opportunity costs of a given level of commitment to defense spending. What would be the impact on the economy of alternative spending levels? Two kinds of effects come to mind: structural effects or the effects of defense spending on the sectoral structure of production, demand, foreign trade, employment, and relative prices; and macro effects, or the effects of defense spending on the size and composition of aggregate output and income. Over the long run, defense spending also affects the long-term productive potential of the economy if resources that might otherwise have been spent on productive capital investment are instead diverted to purchase of military equipment.

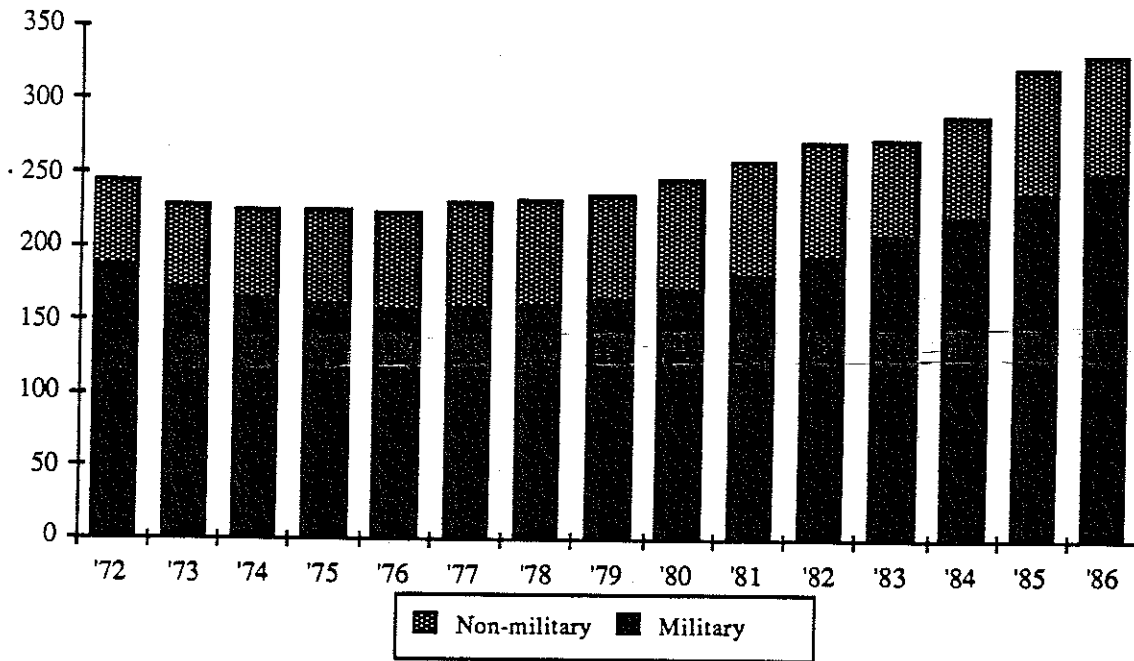
In this paper, we use a Computable General Equilibrium (CGE) model to analyze some of the effects of defense spending on U.S. economic performance. We focus on: (1) the structural and macro effects that would result from a one-time reduction in defense spending and (2) the long-term income and wealth effects that would result from a sustained reduction in defense spending and the reallocation of resources to private investment, private consumption, and the reduction of U.S. debt to the rest of the world. In the next section, we present a summary of the main features of our CGE model and then analyze the results of several counterfactual simulations of the model. Each of these simulations examines how a particular policy of reductions in defense spending affects economic performance.

¹ A very recent and noteworthy exponent of this view is the historian Paul Kennedy [1987].

Figure 1
 Military Spending as a Percent of Federal Expenditure



Federal Government Expenditures on Goods and Services
 (Real, Billions of 1982 Dollars)



2. The U.S. CGE Model

Our CGE model is in the tradition of models developed for the analysis of issues of trade policy.² The model equations describe the supply and demand behavior of the various economic actors across markets for factors and commodities, including exports and imports. The model is neoclassical and Walrasian in spirit, solving for a set of relative prices (including the real exchange rate) that achieve flow equilibria in the various markets. In particular, in all the experiments reported in this paper, the model achieves a full-employment equilibrium, with wages adjusting to clear the labor market. There is no consideration of macro feedbacks that might lead to an unemployment equilibrium.

A simplified version of the model is given in Table 1. Sectoral subscripts have been omitted and the model presented there can be seen as a three-commodity model including a domestic commodity sold on the domestic market, an export commodity not consumed domestically, and an import commodity not produced domestically. The single sector acts as a two-product firm. It produces an aggregate good in equation (1), while equation (2) describes an export transformation function for splitting aggregate output into export and domestic commodities. Equation (3) aggregates the import and domestic commodities into a composite good which is demanded in the home market. In the full model, these equations apply to each sector.

The full model contains eleven sectors, including two primary sectors (agriculture and mining), three industrial sectors (including construction), and six service sectors. Sectoral production functions are all Cobb-Douglas in labor and capital. Both capital and labor are assumed to be completely mobile across sectors, and the model solves for an equilibrium wage and an equilibrium rental rate for capital. The demand for intermediate inputs is given by fixed input-output coefficients.

The model solves for an average equilibrium wage and capital rental rate that "clears" the factor markets, ensuring full employment of labor and capital. However, distortions in the factor markets are also incorporated by specifying that the marginal revenue products of labor and capital in each sector are related to the economywide averages by fixed "distortion" coefficients. These coefficients are estimated from base-year data as the ratio

² For surveys, see Dervis, de Melo, and Robinson [1982] and Shoven and Whalley [1985]. A similar model of the U.S. has been used by Adelman and Robinson [1987] to explore the impact of different macro scenarios in the 1982-86 period.

of the sectoral rate of remuneration for the factor (labor or capital income per unit of employment or capital stock) divided by the economywide average. The ratios vary across sectors for a variety of reasons, including tax and subsidy distortions, market imperfections, and measurement errors arising from the heterogeneity of the factors.

We assume that the factors are homogeneous and that the measured differences in sectoral factor returns are due to distortions. This is also the approach taken in CGE models of the U.S. focusing on tax policy, such as Ballard, Fullerton, Shoven, and Whalley [1985]. With regard to capital, their approach differs from ours in that they assume that all distortions in the capital market are due to tax rate differences, which they measure directly. They then estimate the "effective" sectoral capital stocks as the sectoral denominators that yield equal after-tax sectoral rates of return. We start with direct measures of sectoral capital stocks, compute the sectoral gross rental rates, and then attribute the sectoral differences to "distortions," from whatever source. Their approach assumes that they can independently estimate all sources of capital market distortions, while our approach assumes that we can directly measure sectoral capital stocks.³ Neither approach is completely satisfactory, but our's seems more appropriate for a model focusing on the defense sector, where investment decisions have nothing to do with the workings of the capital market.

The model includes the following actors who receive income and demand goods: households, government, capital account, and the rest of the world. There are three categories of households classified by income level who receive income from wages, profits, rents, and transfers. They save (according to fixed average savings rates) and allocate their consumption expenditure across goods according to a simple linear expenditure system. Aggregate government expenditure on goods is classified into two types, military and non-military, is specified exogenously (in real terms), and is allocated across sectors according to fixed shares. The government receives income from taxes (direct and indirect) which it then spends on goods and transfers to households. Government saving (the deficit) is determined residually as receipts minus expenditures. The capital account deals only in flows from current income, collecting savings from all sources (private, government, and foreign) and spending it on investment goods. The model is static in that the current investment flow is not "installed" or incorporated into

³ Data on sectoral capital stocks were obtained from U.S. Department of Commerce [1987].

sectoral capital stocks as part of an experiment. The aggregate capital stock is specified exogenously.

On the import side, the model specifies product differentiation between imports and domestically produced goods in the same sector. Demanders purchase a "composite" commodity in each sector which is a constant elasticity of substitution (CES) aggregation of domestically produced and imported goods. The effect is that import demand is a function of the ratio of the price in domestic currency of the import (P_m) to that of the domestic good in the same sector (P_d). On the export side, suppliers are assumed to have different production functions for goods sold on the domestic and export markets. Using factor inputs, they produce a "composite" commodity which can then be transformed into goods intended for exporting, versus those destined for the domestic market, according to a constant elasticity of transformation (CET) function. Given the assumption of profit maximization, the ratio of export goods to goods for the domestic market in each sector is a function of the relative price in domestic currency of exports (P_e) and domestic sales (P_d). In effect, each sector is a two-product firm with a separable production function. The determination of the level of aggregate production is based on the producer price of the composite commodity (P_x), while the composition of supply to the export and domestic markets depends only on the relative prices in the two markets (P_e/P_d). With respect to the world market, we retain the standard "small country" assumption. Sectoral world prices of exports and imports are assumed to be fixed exogenously and are independent of the volume of exports and imports.

The effect of this trade specification is potentially to insulate the domestic price system from world prices. In a model in which all goods are tradable and are perfect substitutes with foreign goods, domestic relative prices are completely determined by world prices. By contrast, in this model, all domestically produced goods sold on the domestic market are only imperfectly substitutable with goods either bought from or sold to the rest of the world. This specification yields much more realistic behavior than a model incorporating perfect substitutability and is widely used in CGE models focusing on international trade.

Table 1: A Simplified CGE Model

Real Flows

- (1) $X(L_D, V_D, K_D)$ production
- (2) $X(E, S_d)$ export transformation
- (3) $Q_D(M, D_d)$ import aggregation
- (4) $M/D_d = f_1(P_m, P_d)$ import demand
- (5) $E/S_d = f_2(P_e, P_d)$ export supply
- (6) $\bar{C}_D(P_q, C)$ consumption demand
- (7) $\bar{Z}_D(P_q, Z)$ investment demand
- (8) $V_D(X)$ intermediate demand
- (9) $D_Q = C_D + Z_D + V_D + \bar{G}_D$
- (10) $L_S(W, P_q)$ labor supply
- (11) $L_D(R, W, P_q, P_x)$ labor demand
- (12) $K_D(R, W, P_q, P_x)$ capital demand

Real System Constraints

- (13) $D_D - S_D = 0$ product market
- (14) $L_D - L_S = 0$ labor market
- (15) $K_D - \bar{K}_S = 0$ capital market

Accounting Identities

- (31) $P_x \cdot X = P_e \cdot E + P_d \cdot S_D$ value of output = value of sales
- (32) $P_q \cdot Q_D = P_m \cdot M + P_d \cdot D_D$ value of composite goods = absorption
- (33) $P_x \cdot X = W \cdot L_D + R \cdot K_D + P_q \cdot V_D$ value of sales = value of inputs
- (34) $P_q \cdot C_D = C$ consumption demand = expenditure
- (35) $P_q \cdot Z_D = Z$ investment demand = expenditure

Nominal Flows

- (16) $\bar{Y}_L = W \cdot L_S \cdot (1 - T_L)$ labor income
- (17) $\bar{Y}_K = R \cdot K_S \cdot (1 - T_K)$ capital income
- (18) $\bar{Y}_G = T_L \cdot W \cdot L_S + T_K \cdot R \cdot K_S$ govt income
- (19) $\bar{C}(\bar{Y}_L, \bar{Y}_K)$ consumption function
- (20) $\bar{S}_p = \bar{Y}_L + \bar{Y}_K - \bar{C}$ private saving
- (21) $\bar{M} = P_{\$m} \cdot M$ dollar imports
- (22) $\bar{E} = P_{\$e} \cdot E$ dollar exports

Price Equations

- (23) $P_m = r \cdot P_{\$m}$ import price
- (24) $P_e = r \cdot P_{\$e}$ export price
- (25) $P_q(P_m, P_d)$ composite price
- (26) $P_x(P_e, P_d)$ output price

Nominal System Constraints

- (27) $\bar{S}_p + \bar{S}_G + r \cdot B - \bar{Z} = 0$ savings-investment
- (28) $\bar{Y}_G - P_q \cdot \bar{G}_D - \bar{S}_G = 0$ govt balance
- (29) $\bar{M} - \bar{E} = B$ balance of trade
- (30) $f_3(P_d, P_m, P_e, W) = P$ numeraire

Endogenous Variables

X = aggregate output
 S_D = supply for domestic output
 D_D = demand for domestic output
 E = exports
 M = imports
 Q_D = composite good demand
 V_D = intermediate demand
 L_S = labor supply
 L_D = labor demand
 K_D = capital demand
 C_D = real consumption
 Z_D = real investment
 \tilde{Y}_L = nominal income
 \tilde{Y}_K = capital income
 \tilde{Y}_G = government income
 \tilde{S}_P = private savings
 \tilde{S}_G = government savings
 \tilde{C} = nominal consumption
 \tilde{Z} = nominal investment
 \tilde{M} = dollar value of imports

\tilde{E} = dollar value of exports
 P_m = domestic price of imports
 P_e = domestic price of exports
 P_x = price of aggregate output
 P_d = price of domestic sales
 P_q = price of composite good
 W = wage of labor
 R = rental rate of capital
 r = exchange rate

Exogenous Variables

\bar{G}_D = real government demand
 \bar{K}_S = aggregate capital supply
 \bar{L}_S = aggregate labor supply
 \bar{T}_L = tax rate on labor income
 \bar{T}_K = tax rate on capital income
 B = balance of trade (in dollars)
 $\bar{P}_{\$m}$ = world price of imports
 $\bar{P}_{\$e}$ = world price of exports
 P = numeraire price index

Notes: Variables with a tilde denote nominal magnitudes. Variables with a bar are exogenous. The subscripts d, m, e, x and q refer to the domestic good, imports, exports, output, and the composite good, respectively (D, M, E, X, and Q). The subscripts D and S refer to demand and supply. The subscripts L and K refer to labor and capital. Subscripts P and G refer to private and government. A dot denotes multiplication. There are 29 endogenous variables and 30 equations. The equations, however, are functionally dependent and represent 29 independent equations.

The production function and import aggregation function (equations 1 and 3) are Cobb-Douglas and the export transformation function (equation 2) is CET. Import demand (equation 4) is based on first order conditions for profit maximization or cost minimization. Intermediate demand is given by fixed input-output coefficients (equation 8) and is a function only of output. Equations 25 and 26 are the cost function duals to the import aggregation and export transformation functions. Equation 30 defines the numeraire price index.

The model incorporates a number of different prices in each sector. On the demand side, the price of the composite good (P) corresponds to a retail sales price, and is a weighted average of the domestic currency prices of imports (P_m) and domestic goods sold on the domestic market (P_d). On the supply side, the producer price (P_x) represents an average of the prices in domestic currency of goods sold on the domestic market (P_d) and exports (P_e). The domestic prices of imports and exports are linked to world prices through the exchange rate (equations 23 and 24 in Table 1).

Since the model only determines relative prices, some price must be chosen to define the numeraire. We chose the GNP deflator with 1982 weights. The important point to note is that the model does not incorporate inflation, so all results are effectively measured against 1982 base prices. The base-year solution for the model was calibrated to 1986 data from published government sources.⁴ The calibration yielded macroeconomic aggregates within 0.5% of their real and observed nominal values.

The model focuses on flow equilibria and does not include any asset markets or money. It does, however, incorporate the major macroeconomic aggregate balances (equations 27, 28, and 29 in Table 1): savings-investment, the government deficit, and the balance of trade. How a CGE model achieves balance among these macro aggregates in equilibrium defines the model's "macro closure." Issues of macro closure have been much discussed in the literature on CGE models.⁵ For our analysis, however, the issue is straightforward. Given our assumption of full employment, there can be no significant feedback from macro disequilibrium to employment and aggregate output without increasing resources or the productivity of factor utilization.⁶ The model is Walrasian, not Keynesian.

We assume that aggregate government expenditure on goods is set exogenously in real terms. Government revenue is determined by a variety of taxes, given fixed average tax rates. Government savings (the deficit) is thus determined endogenously, as a residual. Foreign savings (the balance on current account or the balance of trade in goods and services, including factor services) is set exogenously in world market prices. Its value in domestic currency depends on the equilibrium exchange rate. Private savings are generated by using exogenous average savings rates for corporate and household income. Aggregate

⁴ The main sectoral components of this base data are reported in an appendix below.

⁵ This and other current methodological issues are surveyed in Robinson [1988].

⁶ Indeed, we fix aggregate employment and equation (10) is constant.

investment is limited to the sum of all savings. There is no independent investment function and no interest rate variable, so investment is essentially "savings driven."

In the experiments reported below, we vary the government deficit by changing the exogenously specified level of government expenditure on defense. We also vary foreign savings by changing the exogenously specified balance on current account. In the latter case, the real exchange rate must adjust to generate the new equilibrium levels of imports and exports. In both cases, there are major changes in aggregate savings and hence investment. Since the model does not include interest rates or asset markets, we are effectively specifying experiments with complete "crowding out" or "crowding in" of investment. This treatment is adequate given our focus on examining the structural implications of swings in macro aggregates. We are not seeking to explain the process of macro adjustment.

3. Defense Spending Cuts and Economic Performance

In this section we analyze the effects of reduction in defense spending on the U.S. economy. We do this by comparing the 1986 base-year solution of our CGE model with solutions obtained from simulation runs in which defense spending is cut. We evaluate two reference scenarios for defense spending reductions and consider short and long run effects for each scenario.

In one scenario, we assume that the U.S. reduction in defense spending is offset by an increase in defense spending by its NATO allies, so that the 1986 average share of defense spending to GNP across NATO is equalized, but the total spending by the alliance remains unchanged. The reasoning behind this scenario is that the total level of the public good "national security" is held constant. In 1986, the United States spent 6.8% of its real GNP or \$1,063 per capita on defense, while the average figures for all NATO countries, including the U.S., were 5.1% and \$598, respectively.⁷ Since the latter numbers include the United States, they significantly understate the unequal sharing of the defense burden by the NATO allies. An equalization of defense burdens across NATO would have allowed the U.S. to cut real defense spending by 25% in 1986.

⁷ See Office of the President [1987] and U.S. Arms Control and Disarmament Agency [1987].

Alternatively, in the second scenario, we assume that the U.S. engages in substantial unilateral disarmament. To evaluate disarmament against a concrete reference case, we examine scenarios in which the U.S. ratio of defense spending to GNP falls to the level realized in Japan in 1986, i.e. 1% or \$110 per capita. This implies a cut of 89.5% in real U.S. defense spending in 1986. Simulation results based on this extreme assumption indicate the opportunity costs of the overall U.S. defense burden.

Both the defense-equalization and disarmament scenarios are evaluated in two ways: as one-time reductions in U.S. defense spending in 1986; and as long-term reductions in U.S. defense spending since 1972. In the former cases, the aggregate capital stock is held constant in the experiments. The results from these experiments give an idea of the short-term structural effects of such cuts, but it is also important to understand the long-term opportunity costs of a large commitment to defense. For this analysis, we have also simulated the NATO defense-equalization and the disarmament scenarios under the assumption that they had been in force since 1972. The long term spending reductions resulting from these policies are assumed to have been saved and thus to have contributed to capital stock growth over the intervening 14 years. In each year, defense spending was cut to the appropriate level (either NATO=5.1% or Japan=1% of real GNP) and the amount of the reduction added to capital accumulation from the previous years. The resulting increased capital stocks, about 3% greater for defense-equalization and 19% for disarmament, were used to simulate the 1986 economy.

The use of accumulated capital stocks in a comparative static simulation finesses a number of dynamic questions. In the long-run simulations, the compositional effects of each scenario could be expected to have taken place in each year since 1972. Given multiplier/accelerator interactions, our simulations probably understate the investment stimulus. The present approach captures only the exogenously specified effect on the aggregate capital stock.

3.1 Macroeconomic Results

The macroeconomic results of four experiments are displayed in Table 2. Experiment 1 represents a one-time 1986 cut of about 25% in U.S. defense spending, corresponding to the equalization of NATO defense spending across the alliance. In this experiment, the initial aggregate budgetary savings are allocated to reduce the trade deficit

(foreign capital inflows). Experiment 2 is the long-term defense-equalization scenario, with increased capital stock and the budgetary savings allocated as in Experiment 1. Experiment 3 corresponds to the short-term disarmament scenario, where 1986 defense spending is cut to Japanese levels. In this case, the potential budgetary savings (\$224.28 Billion) exceeded the trade imbalance, so the remainder (\$81.28 Billion) was allocated to household transfers. Experiment 4 is the long-term version of the disarmament scenario, with reductions allocated as in Experiment 3.

When interpreting the results of the four experiments, two sources of macroeconomic effects must be distinguished. The first, which might be termed "macro-macro," reflects the direct impact of exogenous changes in macroeconomic variables. Given the macro closure of the model, the trade balance (exactly) and the government deficit (approximately) are specified exogenously. Thus, the initial impact of a reduction in defense spending is exogenously allocated between the savings-investment and trade balances. The ultimate impact of any macroeconomic shock, however, depends on microeconomic interactions across markets in the model, and these effects might be described as "micro-macro." In the present results, for example, factor reallocations lead to changes in real GNP, savings, and government revenues. These micro-macro linkages play a significant role in the macro adjustments observed in the experiments.

Table 2: Macroeconomic Results

	Difference from Base					Ratio to Base			
	Base	Exp 1	Exp 2	Exp 3	Exp 4	Exp 1	Exp 2	Exp 3	Exp 4
Real Aggregates (1982 Billions)									
GNP	3706	33	73	95	342	1.01	1.02	1.03	1.09
Consumption	2495	9	31	70	201	1.00	1.01	1.03	1.08
Investment	588	20	38	99	215	1.03	1.06	1.17	1.37
Inventories	13	0	0	0	1	1.00	1.01	1.03	1.07
Government	755	-63	-63	-224	-224	.92	.92	.70	.70
Exports	375	41	46	102	134	1.11	1.12	1.27	1.36
Imports	520	25	20	48	16	.05	.04	.09	.03
Private GNP	2951	96	136	320	567	1.03	1.05	1.11	1.19
Capital Stock	8976	0	268	0	1721	1.00	1.03	1.00	1.19
Trade Balance	-145	101	101	187	186	-.70	-.70	-1.29	-1.28
Govt Balance	-149	79	88	248	308	-.53	-.59	-1.66	-2.07
Incomes (1986 Billions)									
Laborers	2226	8	19	182	34	1.00	1.01	1.08	1.02
Proprietors	149	3	8	16	4	1.02	1.05	1.11	1.03
Enterprises	512	15	47	41	13	1.03	1.09	1.08	1.03
Poor HH	631	4	34	48	6	1.01	1.05	1.08	1.01
Middle HH	1394	9	38	113	21	1.01	1.03	1.08	1.02
Rich HH	1433	13	43	118	25	1.01	1.03	1.08	1.02
Real Exchange Rate Index									
Real Exch Rate	1.00	.04	.04	.11	.09	1.04	1.04	1.11	1.09

Figure 3
Changes in Real Macro Aggregates
(Billions of 1982 Dollars)

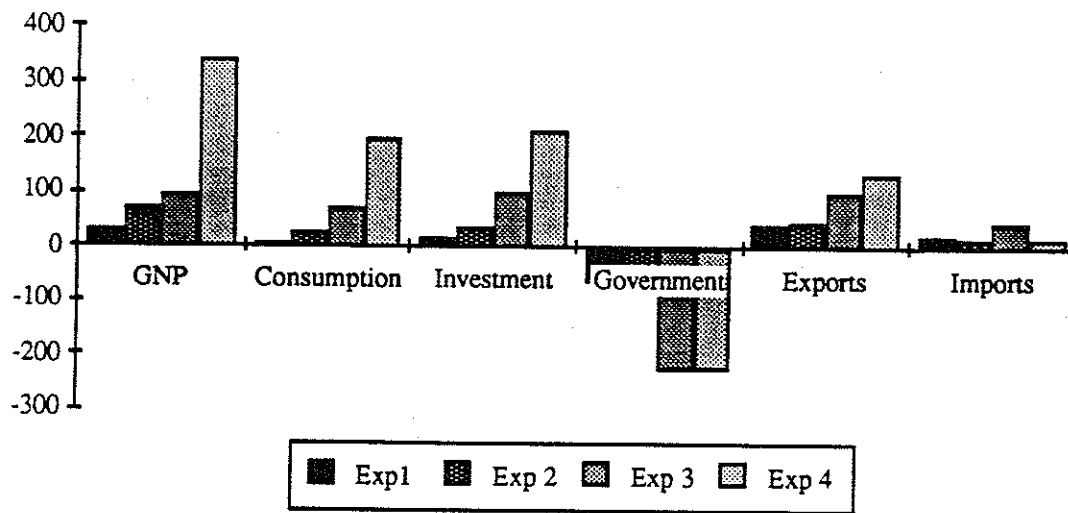


Figure 3 presents the real macroeconomic aggregates for the four experiments. Compositional differences are apparent among the macro aggregates, and these are consistent across experiments. Real income growth is exhibited even in the short-term scenarios (1 and 3), despite the constant capital stock and full-employment assumptions. For example, in Experiment 1, reducing real military expenditure by \$63 Billion leads to an increase in real GNP of \$33 Billion. This new income is due to productivity gains realized by shifting factors from Military Administration to private sectors of the economy. Table 3 below shows the sectoral composition of value added for the base 1986 U.S. data, as well as relative sectoral wages (Wdist) and rental rates (Rdist), measured as ratios to their economywide averages. The latter data indicate that both labor and capital have below-average factor prices in the public sectors. In the case of labor, the differences are small, but the apparent distortion in the capital market, as argued above, is substantial. In a neoclassical model such as ours, these factor prices reflect productivity differentials. Thus, the fixed total endowment of labor and (especially) capital could be reallocated from the public sectors in a way which raises total output and income. This typifies the micro-macro effects described above.

Table 3: Base Sectoral Real Value Added, Normalized Factor Prices, and Federal Government Consumption Shares

<u>Sector</u>	<u>Base VA (\$ Billions)</u>	<u>VA Share (Percent)</u>	<u>Wdist</u>	<u>Rdist</u>	<u>Fed Mil (Percent)</u>	<u>NonMil (Percent)</u>
Agriculture	104	2.2	.50	2.81	.0	10.6
Mining	119	3.2	1.43	2.19	.1	.1
Construction	155	4.2	1.01	6.34	3.7	8.6
Nondurable Mfg	306	8.3	1.00	2.76	8.7	3.2
Durable Mfg	499	13.5	1.16	2.91	36.9	13.1
Trans, Comm, Utility	330	8.9	1.23	1.19	5.0	3.9
Wholesale & Retail Trade	636	17.2	.74	2.60	2.6	1.6
Finance, Ins., and Real Est.	555	15.0	1.10	.60	.3	2.3
Services	598	16.1	.84	2.21	7.5	16.0
Civil Admin	326	8.8	1.00	.04	.0	40.6
Military Adm	79	2.4	.90	.11	35.1	.0

While the increases in real GNP are substantial, even greater gains are attributable to the private sector as a result of both productivity and reallocation effects. Changes in "Private GNP," defined as real GNP excluding government consumption (C+I+E-M), are

about two and one half times those of total GNP in these experiments. Even with no changes in the aggregate capital stock, reductions in defense expenditure lead to increases in real Private GNP of \$96-320 Billion (Experiments 1 and 3). These results illustrate the "crowding out" of private productive capacity by a growing defense sector. Apart from the implied loss of aggregate output, increased military expenditure also leads to "de-industrialization", i.e. a shift in the structure of production in favor of the service sectors. This phenomenon will be discussed in greater detail below.

On December 3, 1987, Secretary of Defense Carlucci announced proposed nominal cuts of \$33 Billion in the 1988 defense budget. This amount, which is equivalent to \$26 Billion at 1982 prices, represents a far smaller cut than the defense-equalization scenario. We have run the Carlucci cuts on our model and the qualitative features of their impact are consistent with the above experiments. For example, our results indicate that the proposed cut would lead to an increase in real GNP would of \$10 Billion and in Private GNP of \$35 Billion.

All the macroeconomic aggregates except Imports follow real GNP and are influenced by a combination of the macro-macro and micro-macro effects discussed earlier. For example, the real exchange rate, measuring the dollar price of domestic tradable goods in terms of nontradables, rises (the rate *depreciates*) in all four experiments. This follows from our specification of an exogenous improvement in the trade balance (macro-macro), with the exchange rate adjustment inducing the necessary export expansion and import substitution (micro-macro). To test the robustness of our analysis, we replicated our experiments with alternative macro reallocations of the budgetary savings. The results indicate that while the structure of private production is sensitive to variations in macro assumptions, the aggregate real income and product gains are unaffected.

Capital accumulation from sustained reductions in defense spending leads to substantially larger aggregate output than in the fixed capital stock experiments (1 and 3). Long-term reduction to Japanese levels of defense expenditure since 1972 (Experiment 4) would yield in 1986 a 19% increase in the stock of domestic capital, a \$342 Billion (9%) increase in real GNP, and a \$567 Billion (19%) increase in Private GNP. The cumulative gains over the entire period would, of course, have been much greater. Note, however, that a one-time reduction to Japanese defense expenditure levels (Experiment 3) yields a larger gain than that arising from fourteen years of increased investment under the long-

term NATO defense-equalization scenario (Experiment 2). Comparison of Experiments 3 and 4 gives an indication of the role of incremental capital.

3.2 Sectoral Results

Turning to Figures 4-6 below, we can examine the effects of the four experiments on the sectoral composition of value added and the components of national income. Figures 4 and 5 indicate changes in sectoral real value added in level (1982 Billions) and percent terms, respectively, arising from the four experiments. In all cases, sectoral responses are driven by three main forces. The first is private demand growth in response to increased income. Secondly, the share of investment in real GNP rises in all four experiments, especially in 3 and 4, shifting the composition of sectoral demand in favor of capital goods (e.g., Construction and Durables). Thirdly, devaluation effects drive sectoral expansion for export sales and import substitution. This last effect is particularly beneficial to Agriculture.

The growth of real total and Private GNP drives the overall sectoral responses, but the other two factors do lead to significant compositional differences. All four experiments have different effects on the composition of domestic production and prices, effects which could only be tenuously inferred from the macro results. All experiments hit the Military Administration sector hard, since it experiences the initial impact of the decline in government demand⁸. Apart from absolute contraction in this sector, however, all other sectors, *including* Civil Administration, increase their value-added in response to the cuts because of the overall increase in real GNP.

From Figure 5, it is apparent that, in all experiments, the expansion of primary and manufacturing sectors exceeds that of all service sectors (Wholesale and Retail Trade, Finance, Services, and public administration). It is often asserted that industrial sectors are the principal beneficiaries of military expenditure. Our results, which take account of general equilibrium effects, contradict this assertion. The net impact of cuts in defense expenditure, including both direct and indirect economic linkages, is to increase the relative

⁸ The percentage changes in real value added for Military Administration were omitted to improve the scaling of Figure 5. They were -20% for defense-equalization and -71% for disarmament. Note that the sector shrank less than the amount of the cuts, -25% and -89% respectively, benefitting indirectly from economic expansion.

Figure 4
Change in Sectoral Real Value-added
(Billions of 1982 Dollars)

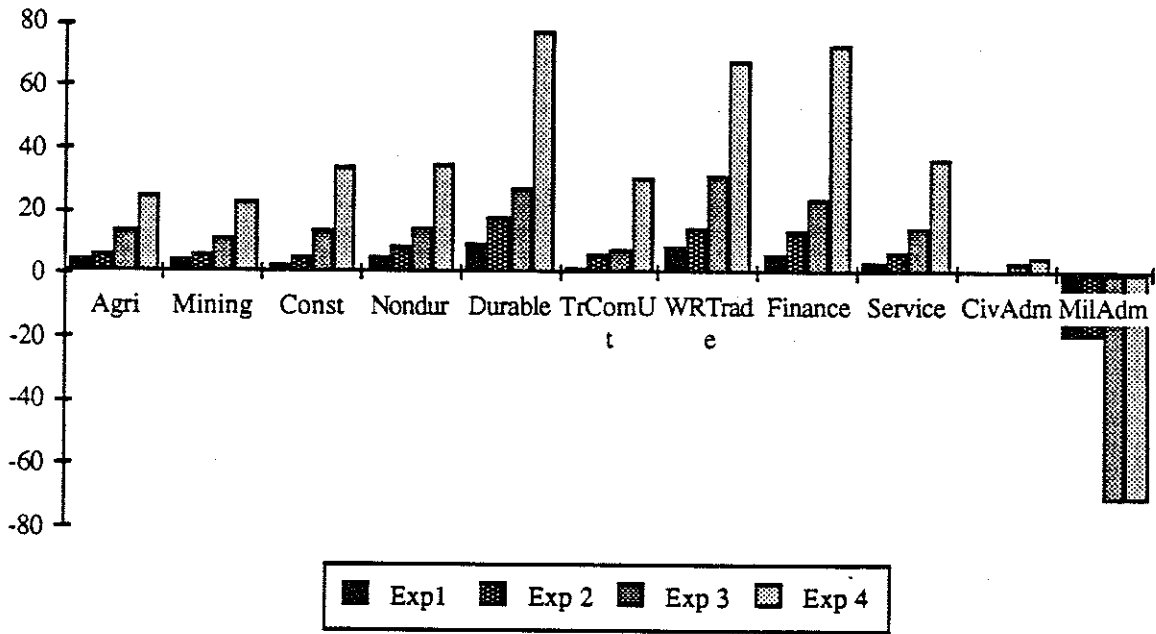
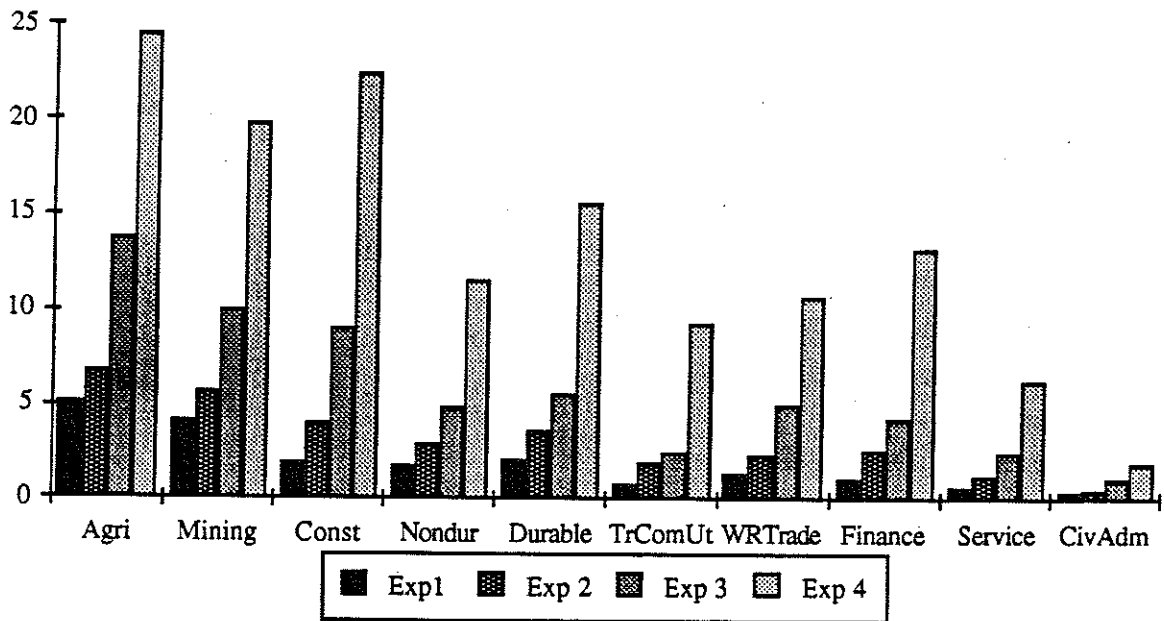


Figure 5
Change in Sectoral Real Value Added
(Percent)



share of the industrial sectors in economic activity. It is evident from these results that, in an highly articulated market system such as the U.S. economy, the industrial sectors benefit greatly from both intermediate demand and income-expenditure linkages. Data in Table 3 indicate that almost half of defense spending is allocated to services, principally Military Administration, a sector with very weak backward linkages to the rest of the economy. Any policies designed to promote "re-industrialization" in the U.S. should therefore take explicit account of the bias against the industrial sectors arising from high levels of defense expenditure.

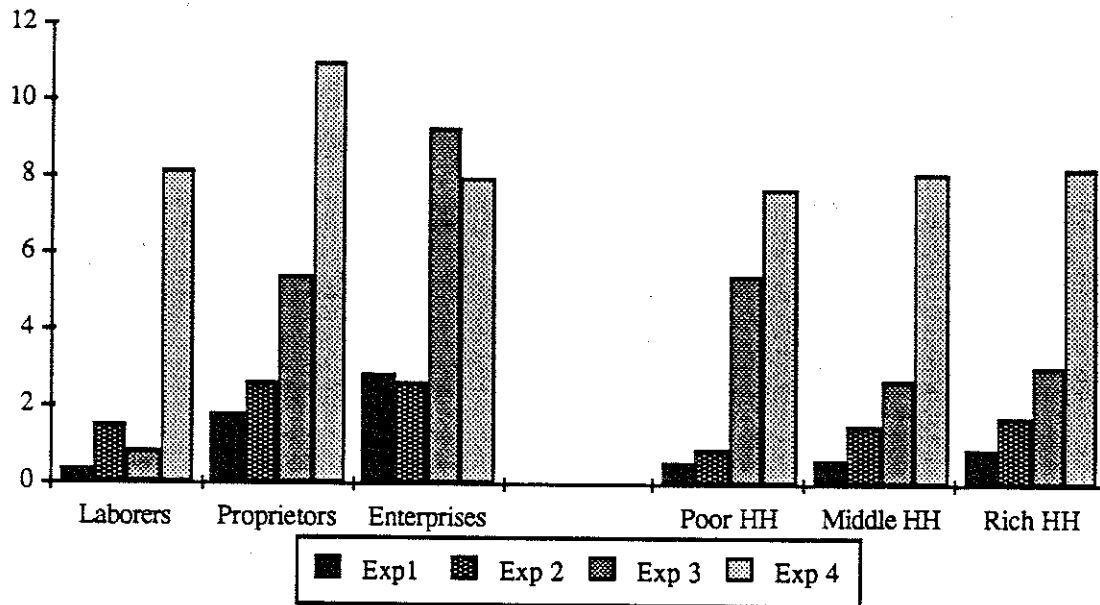
Analysis at higher levels of disaggregation would reveal a more variegated pattern of winners and losers among industries. A natural framework for capturing such detail is provided by linear multiplier models. A linear model does not capture relative price effects, but can conveniently incorporate enormous sector detail. This literature has a long history, beginning with Leontief who has made a number of contributions in the context of defense reductions⁹. These methods have also been extended to Social Accounting Matrices, where they take account of more extensive transmission linkages.¹⁰

Figure 6 gives an indication of the composition of income effects resulting from the four experiments. The left side of the figure is divided into national income categories analogous to functional determinants of income, the right into households classified by income level. In the factor-oriented distribution, Enterprises benefit most in Experiments 3 and 4. Income growth is greatest for the Laborer and Proprietor groups in Experiment 4, the Proprietor group benefitting most. In general, profit income (both to Proprietors and Enterprises) rises more than wage income. Thus, disarmament favors the owners of capital in the private sector, which is in accordance with the results on re-industrialization discussed earlier.

⁹ See Leontief [1986], Chapters 9 and 10.

¹⁰ See e.g. Roland-Holst [1987] and Robinson and Roland-Holst [1988].

Figure 6
Changes in Institutional and Household Incomes
(Percent)



Factor price changes play a major role in equalizing the gains in the long-term experiments. In Experiments 2 and 4, increased capital stocks lead to a relative scarcity of labor and therefore a higher wage relative to the return to capital. This is especially apparent in Experiment 4, where the capital stock rose by 19%. In the size distribution, the Rich Households benefit most in the defense-equalization experiments. In Experiment 3 (disarmament with a fixed capital stock), Poor Households benefit significantly from the assumed increased transfers, but their gains are even greater in Experiment 4, where wages rise dramatically. The relative uniformity of percentage income gains across household groups in the last experiment is due to wages rising, favoring the groups with high wage shares in total income.

5. Conclusion

The results from our experiments indicate that reductions in defense spending will lead to significant increases in real GNP, and several-fold greater increases in real output and income in the private sector. Assuming that the budgetary savings from sustained reductions are at least partially available for investment, increased capital stock growth expands the productive base of the economy. In all our experiments, reductions in military expenditure shifted the composition of macro aggregates in favor of the private sector and the composition of output in favor of the industrial sectors. Thus, it is apparent that the opportunity costs of defense spending include substantial foregone private income and de-industrialization.

Our results are subject to a number of qualifications. We made no attempt to model the macro reallocation of the budgetary savings endogenously. The actual reallocation would depend on political as well as economic considerations. Sensitivity analysis indicates that our broad results are robust, but different macro scenarios would certainly yield different results at the sectoral level. At the micro level, the model assumes that the economy is able to adjust commodity and factor prices, reallocate factors of production, and maintain full employment. This neoclassical flexibility brings the market components of the economic adjustment into high relief, but it can complicate policy interpretation in the context of the real economy. The model includes no short-run adjustment costs or disruptions arising from major shifts in policy. Many of the adjustments we model would inevitably take time to complete, and we make no attempt to model the dynamic path the economy would follow in achieving the new equilibrium. Thus our results are best viewed as providing indications about the direction and relative impetus of the components of economic adjustment.

In his recent study, the historian Paul Kennedy raises the disturbing prospect that large and sustained commitments to spending on national defense is precipitating a long-term relative decline of the U.S. economy. As economists, we are not in a position to evaluate how much national defense the U.S. "needs." However, we have attempted to analyze the opportunity cost of defense expenditure in terms of lost output and wealth, and diversion of income away from the private sector. Our results give quantitative support to Kennedy's economic conclusions. The numbers are large, amply justify his concern, and should help focus attention on a major long-run policy problem.

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Appendix

Table A1: Base Social Accounting Matrix: Macro SAM
(Billions of 1986 Dollars)

	Comm	Act	Value Add	Insttns	Hshlds	Cap Acct	GovtROW	Total
Commodity		3822			2799	668	865	8531
Activity	8037						377	8037
Value Added		4215						4215
Institutions			3868				23	3892
Households				2888			571	3458
Capital Acct				525	152		-149	668
Government	13		347	479	507			1310
Rest of World	481						-36	481
Total	8531	8037	4215	3892	3458	668	1310	481

Table A2: Base Sectoral Structure (All shares are in percentage terms)

	Value-added Share	Intermed. Share	Labor Share	Capital Share	Cap/Lab Ratio	Import/ Output	Export/ Output
Agri	2.8	6.8	1.7	1.8	3.7	3.8	8.8
Mining	3.2	7.7	.8	3.1	12.8	41.2	3.6
Const	4.2	2.4	4.3	.6	.4	.0	.0
Nondur	8.3	19.7	8.1	3.7	1.6	8.7	5.3
Durable	13.5	23.0	10.8	4.8	1.5	16.1	10.6
TrComUt	8.9	12.1	5.3	11.2	7.3	.0	2.6
WRTrade	17.2	8.1	21.0	4.4	.7	.0	2.7
Finance	15.0	8.1	6.5	43.9	23.3	.1	.7
Service	16.1	10.7	23.3	3.6	.5	11.4	9.4
CivAdm	8.8	1.3	14.3	18.5	4.5	.0	.2
MilAdm	2.1	.0	3.7	4.4	4.1	.0	.0
Total/Average	100.0	100.0	100.0	100.0	5.5	7.4	4.0

Table A3: Miscellaneous Model Parameters

	CET			Armington		
	Share	Shift	Elasticity	Share	Shift	Elasticity
Agriculture	.68	2.40	3.00	.27	1.55	3.00
Mining	.81	3.03	2.00	.29	1.76	2.00
Construction	.99	21.53	2.00	---	---	---
NonDurable Mfg	.77	2.75	2.00	.17	1.40	2.00
Durable Mfg	.72	2.44	2.00	.10	1.45	2.00
Trans, Comm, Utility	.84	3.46	2.00	---	---	---
Wholesale & Retail Trade	.86	3.66	2.00	---	---	---
Finance, Ins., Real Estate	.92	5.38	2.00	1e-04	1.00	2.00
Services	.98	4.36	.60	3e-05	1.16	.60
Public Administration	1.00	50.22	.60	---	---	---
Military Administration	---	---	---	---	---	---

