THE CBO MULTIPLIERS PROJECT:
A METHODOLOGY FOR ANALYZING THE EFFECTS OF ALTERNATIVE ECONOMIC POLICIES

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A Methodology for Analyzing the Effects of Alternative Economic Policies

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PREFACE

This study presents some of the technical material used by the Congressional Budget Office in analyzing the impact of alternative economic policies. It was written by Mary Kay Plantes and Frank de Leeuw. Nancy Morawetz and Michael Owen performed many of the model simulations. The paper was typed by Dorothy J. Kornegay and edited by Patricia H. Johnston

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SUMMARY

At the peak of the budget season, CBO is called upon several times a week to estimate the impact on the economy of a change in the federal budget. These estimates are quite sensitive to which macroeconomic model or other procedure is used to prepare them. The multipliers project is an attempt to understand and deal with the diversity of results that various models may produce.

The project consists of (a) systematic comparison of econometric model estimates of the impact of changes in fiscal policies, and (b) selection of a uniform set of procedures for calculating policy impacts. The systematic comparison involves the factoring of an overall GNP multiplier--the amount of GNP generated per dollar of a spending increase or a tax cut--into a number of key components, including:

- the ratio of the change in consumption to the change in disposable income;
- the ratio of the change in investment in housing, plant, and equipment to the change in GNP;
- the ratio of the change in "other GNP" (inventories, state and local purchases, net exports) to the change in GNP;
- the fraction of a change in GNP going into wages and salaries and other labor income and nonwage income;
- the fraction of a change in GNP serving to reduce transfer payments; and
- the fraction of a change in wages and salaries and other labor income and nonwage income going into personal tax payments.

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With the aid of this factoring, differences in policy multipliers among models can be traced back to differences in one or more of these key ratios.

The selection of a uniform set of procedures begins with choosing a value (or, more precisely, a set of quarterly values) for each of these key ratios on the basis of reasonableness, other empirical studies, and, when necessary, simply averaging across models. The values of the key ratios determine CBO's overall GNP multipliers. To go beyond GNP to real and price effects, employment impacts, etc., CBO makes use of a number of simple relationships, including Okun's law and a two-equation, wage-price model. This paper focuses largely on the first step in the multipliers project, the factoring of GNP multipliers into their major components. The final section discusses briefly the other relationships used by CBO.

CHAPTER I. INTRODUCTION

At the peak of the budget season, CBO is called on several times a week to evaluate the impact on the economy of a change in the federal budget. Occasionally clients ask for a specific econometric model, but usually the choice of methodology is left to CBO. Most clients are not aware of how sensitive the results can be to the model chosen. For example, one well-known econometric model says a $10 billion annual sustained increase in government purchases causes a decrease in prices lasting for one and one-half years under current conditions; another says that the same policy action causes a 0.3 percentage point increase in the rate of inflation during the same interval. While continually reminding users of the uncertainty of policy impact estimates, CBO also strives to make sense out of the diverse estimates.

This diversity of results is the basic reason for the multipliers project. Not only does CBO need a uniform set of procedures for measuring policy impacts, but it ought to understand why models now widely used on Capitol Hill differ so much in their policy implications. Furthermore, CBO is frequently called on to deal with quite specialized fiscal instruments, such as public service employment and countercyclical revenue sharing, that are not incorporated in most models. It is highly useful to have a procedure that enables CBO to standardize the treatment of the rate of fiscal displacement in public service employment, the average salary paid to public employees, and other matters relevant to these instruments.

The multipliers project consists of (a) systematic comparison of econometric model results for step changes in fiscal policies, and (b) selection of a uniform set of procedures for calculating policy impacts. The systematic comparison involves factoring an overall Gross National Product (GNP) multiplier into a number of key components--for example, the ratio of investment change to GNP change or the ratio of consumption change to a change in disposable income. (The relation of overall multipliers to these key ratios is shown in equation (8) on page 12). With the aid of this factoring, differences in policy multipliers among models can be traced back to differences in one or more of these key ratios.

The selection of a uniform set of procedures begins with choosing a value (or, more precisely, a set of quarterly values) of each of these key ratios on the basis of reasonableness, other empirical studies, and when necessary, simple averaging across models. The values of the key ratios determine the size of the overall GNP multipliers. To go beyond current-dollar GNP to output price effects, employment impacts, etc., CBO uses a number of simple relationships, including Okun's law and a two-equation, wage-price model.

Most of the remainder of this paper describes the first step in the multipliers project, the factoring of GNP multipliers into their major components and comparing these components across models. The final section discusses briefly the other relationships that are used in addition to the GNP multipliers in measuring policy impacts.

The model simulation results that have been used as the starting point of this analysis depend on initial conditions. They depend, for example, on whether interest rate levels are high or low and whether there is a lot of excess capacity in the economy or not. The multipliers presented in this paper refer to the conditions of the U.S. economy as of early 1977. The analysis needs to be redone whenever there is a substantial change in initial conditions. CBO's tentative plan is to redo it once a year.

CHAPTER II. FACTORING FISCAL POLICY MULTIPLIERS

A simple income-expenditure model is the starting point for factoring GNP multipliers into key components. This chapter presents the simple model; the following chapter presents a number of extensions.

The basic model, which is shown on the following page, consists of an identity expressing GNP identity as the sum of five components and six additional equations relating changes in the components of GNP to their determinants. The parameter estimates for the income-expenditure model are derived from simulating step changes in fiscal policy in full-scale econometric models. While the basic multiplier model itself is simple in structure, each of its coefficients summarizes a wide range of price and wealth responses as well as income-expenditure relationships incorporated in the full-scale models.

For example, one of the coefficients in the simple model (a_2) is the ratio of a change in fixed investment to a change in GNP. The value of this ratio in a particular model is not simply a naive accelerator coefficient but rather reflects the net outcome of all the investment determinants in that model, including accelerator-type forces, cost of capital components, and a range of other influences (all as of early 1977). The ratio could be less than zero in a model with very strong "crowding-out" forces, or it could be greater than zero in a model with strong accelerator-type forces. The same is true of the other coefficients in the simple income-expenditure model; they too summarize net outcomes of complex influences represented in the actual models CBO has used.

The coefficients of the basic model are thus reduced-form rather than structural relationships. While they are reduced-form relationships, they are, however, much closer to observable economic magnitudes--for example, the share of personal income in GNP--than are the fiscal policy multipliers of which they are components. It is scarcely possible to develop any a priori judgments to which to compare policy multipliers, but it is possible to form judgments about some of the ratios investigated in this study.

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BASIC MULTIPLIERS MODEL

(1) $\Delta GNP\$(t) = \Delta C\$(t) + \Delta FI\$(t) + \Delta GG\$(t) + \Delta GE\$(t) + \Delta X\$(t)$

(2) $\Delta C\$(t) = a_{1t}(\Delta INC\$(t) + \Delta TR\$(t) - \Delta TP\$(t))$

(3) $\Delta INC\$(t) = b_{1t}\Delta GNP\$(t) + c_{1t}\Delta GE\$(t)$

(4) $\Delta TR\$(t) = -b_{2t}\Delta GNP\$(t) - c_{2t}\Delta GE\$(t) + \Delta TRO\$(t)$

(5) $\Delta TP\$(t) = b_{3t}\Delta INC\$(t) - c_{3t}\Delta GE\$(t) + \Delta TPO\$(t)$

(6) $\Delta FI\$(t) = a_{2t}[\Delta GNP\$(t) - \Delta GE\$(t)]$

(7) $\Delta X\$(t) = a_{3t}\Delta GNP\$(t) + \Delta XO\$(t)$

(all variables are in current dollars)

where

GNP$	=	Gross National Product
C$	=	Consumption
FI$	=	Fixed investment (business and residential)
GG$	=	Federal government purchases except public employment
GE$	=	Public employment spending net of displacement, federal and state and local (displaced funds used for tax reduction or general state and local spending enter as TP$ or GG$)
X$	=	Rest of GNP$: inventory investment, net exports, state and local spending other than public service employment
INC$	=	Wages and salaries and other labor income and nonwage income
TR$	=	Federal transfer payments
TP$	=	Federal personal tax revenues (including employee payroll taxes)
TRO$	=	Intercept, transfer payments
TPO$	=	Intercept, personal tax revenues
XO$	=	Intercept, other spending
t	=	Time, in quarters

Simulations of fiscal policy in full-scale models are used to derive coefficients for the simple model. Each econometric model simulation yields a specific set of values for the key components that together capture the total change in GNP implied by that model. The GNP multiplier is an algebraic function of the coefficients of the basic model, called "key components" of the multiplier.

As the tables below show, wide disparities sometimes exist between different estimates of the key components. Frequently, an unusually high or low estimate can be traced to an unreasonable structural specification in the underlying model. Values of key components chosen for this policy simulation work were based on what CBO felt were the more reliable model estimates. In cases where CBO had little insight into the reliability of values derived from the econometric models, simple averaging across models was necessary.

The key components depend on the period of time over which relationships between components of GNP and their determinants are measured. The (approximate) marginal propensity to consume, a_1, for example, can refer to consumption changes divided by income changes during the first quarter of a sustained change in fiscal policy, during the second quarter, or during a later quarter. CBO's procedure has been to derive quarterly values for each of the coefficients for the first through the tenth quarter. In effect, the model is 10 different models, which together measure the dynamic adjustment path accompanying a policy change.

KEY COMPONENTS OF FISCAL POLICY MULTIPLIERS

Equation 1, the GNP identity, expresses changes in GNP as the sum of changes in consumption, fixed investment, government spending on goods and services other than public employment programs, government spending on public employment programs, and "other GNP" (namely, inventory investment, net exports, and state and local spending other than federally financed public service employment).

The next block of four equations relate to consumption and its determinants. The first, (2) expresses changes in consumption as a fraction of changes in disposable income. Changes in disposable income include changes in wages and salaries, plus other labor income plus nonwage income, changes in

personal transfer receipts minus changes in personal tax payments. Values of the parameter of this equation, a_1, are shown quarter by quarter for five econometric models--Data Resources, Inc., (DRI), Wharton, Chase, MIT-Penn (MPS), and Fair--and for the multipliers model in Table 1. 1/ The latter values can be adjusted if the policy change is targeted on population groups whose (approximate) marginal propensities to spend are significantly different from the average values reported here.

TABLE 1. QUARTERLY VALUES OF a_1

Quarter	Models					Basic Multipliers Model
	1	2	3	4	5	
1	.41	.26	.55	.25	.68	.35
2	.63	.26	.47	.37	.80	.45
3	.68	.28	.56	.44	.95	.51
4	.71	.30	.65	.51	.97	.55
5	.73	.39	.68	.58	1.02	.60
6	.73	.49	.67	.62	.96	.62
7	.73	.69	.69	.65	.97	.67
8	.71	.83	.70	.70	.98	.70
9	.71	.75	.70	.72	.95	.71
10	.71	.67	.70	.76	.90	.71

1/ Parameter values from econometric models reported in Tables 1, 2, 4, and 5 were derived by simulating a change in federal government purchases, holding the path of unborrowed reserves constant. For a number of models, results vary significantly with the monetary variable selected as exogenous. Selecting unborrowed reserves implies that both interest rates and the money supply rise moderately in response to an expansionary fiscal move.

The quarterly values of a_1 are considerably lower than the average ratio of total consumption to total disposable personal income. This difference arises from the existence of wealth-induced consumption flows that are relatively insensitive to changes in disposable income and, therefore, not measured by a_1. The ratio of total consumption, which includes wealth-induced consumption, to disposable income averaged over 0.9 for both the past five- and ten-year periods.

The next equation in the consumption block,(3), relates changes in wages and salaries and other labor income and nonwage income to changes in GNP and changes in public service employment outlays. The first parameter of this equation, b_1, is estimated on the basis of econometric model results that are shown in Table 2.

TABLE 2. QUARTERLY VALUES OF b_1

	Models					Basic Multipliers
Quarter	1	2	3	4	5	Model
1	.78	.33	.27	.40	.28	.42
2	.77	.41	.45	.59	.39	.54
3	.80	.45	.55	.62	.44	.60
4	.82	.50	.57	.65	.46	.63
5	.83	.54	.61	.67	.49	.66
6	.84	.54	.68	.71	.55	.69
7	.85	.48	.71	.73	.56	.71
8	.87	.46	.74	.74	.59	.73
9	.88	.55	.77	.76	.61	.75
10	.89	.71	.79	.76	.65	.78

The share of wages and salaries, other labor income, and nonwage income in GNP has averaged about .75 over the past five- and ten-year periods. Quarterly values of b_1 used in the multipliers model are initially lower than the average share due to the disproportionate rise in profits immediately following a policy-induced income change. In later quarters, nonprofit income shares rise above their average value. This occurs because depreciation, which is subtracted from GNP to obtain national income levels, is very slow to change in response to changes in GNP. Nonprofit income shares will return to their average value after the depreciation adjustment is complete.

The second parameter in the income equation, c_1, reflects the difference between the fraction of public employment programs going into wage income (more precisely, wages and salaries plus other labor income plus nonwage income), and the fraction of other components of GNP that goes into wage income. Its value is not estimated from econometric models but rather is estimated on the basis of experience under public employment programs and legislative provisions of such programs.

The next equation, (4), in the consumption block relates changes in transfer payments to changes in GNP and outlays on public employment programs. Estimates of the first parameter in this equation, b_2, were derived from econometric model results and empirical studies of transfer payments. The second parameter in this equation, c_2, represents the difference between the transfer reduction rate of public employment programs and that of other changes in GNP. Like c_1, it is estimated on the basis of experience under public service employment and program design considerations. A public employment program targeted at youth, for example, would have a lower value of c_2 than one targeted at adults. The final term in the equation, $\Delta TRO\$$, measures policy-induced changes in transfer payments.

The final equation in the consumption block, (5), relates changes in personal tax payments to changes in GNP and outlays on public employment programs. Its specification is analogous to that discussed above for transfer payments and its parameters were estimated in an identical fashion. Table 3 lists the values of equation (4) and (5) parameters used in the basic multipliers model.

TABLE 3. ESTIMATED VALUES OF b_2, b_3, c_2, a/ and c_3 a/ USED IN THE BASIC MULTIPLIERS MODEL

	Parameters			
Quarter	b_2	b_3	c_2	c_3
1	.03	.167	.19	.05
2 - 10	.07	.167	.19	.05

a/ c_2 and c_3 vary according to program design. Values reported in Table 3 are used for public employment programs that are directed at long-term unemployed adults.

Equation (6) expresses changes in fixed investment (business and residential) as a fraction of changes in GNP other than government employment spending. Quarterly values of this ratio, a_2, are shown for five econometric models and the basic multipliers model in Table 4. Historically, the share of fixed investment in GNP has averaged 0.14 in the past five- and ten-year periods. Quarterly values of a_2 may be expected to approach the average share after accelerator influences, which raise the value of a_2 above the average share, cease operating.

TABLE 4. QUARTERLY VALUES OF a_2

Quarter	Models 1	2	3	4	5	Basic Multipliers Model
1	.02	.07	.03	.04	.08	.06
2	.03	.12	.05	.10	.14	.11
3	.04	.18	.07	.14	.17	.17
4	.05	.21	.09	.16	.21	.19
5	.06	.22	.08	.18	.22	.20
6	.06	.23	.06	.18	.25	.20
7	.05	.23	.04	.18	.24	.19
8	.05	.22	.03	.17	.24	.18
9	.03	.16	.01	.16	.24	.16
10	.03	.06	-.01	.16	.24	.14

The final equation, (7), in the basic multipliers model relates changes in the remaining GNP components--inventory investment, net exports, and state and local spending other than federally financed public service employment--to changes in GNP. The intercept-change term reflects exogenous changes in net exports and state and local spending. Table 5 lists quarterly values of the parameter of this equation, a_3, for five econometric models and the basic multipliers model.

The models yield different values for key parameters when the policy simulated is a change in federal government purchases rather than when the policy is a change in personal tax receipts. The differences are significant, however, only with respect to a_3. This is due to the more rapid change in import spending that occurs following an exogenous change in personal taxes. The estimated values of a_3 used in the multipliers model differ, therefore, depending on whether the policy being considered is similar to a tax change or similar to a purchase change. Table 5 reports only values of a_3 based on a

purchase change for the five models, but presents both sets of values for the multipliers model.

The share of the remaining GNP components in GNP has averaged 0.144 over the past five years and 0.138 over the past ten years. These ratios are significantly higher than quarterly values of a_3 reported in Table 5, principally because of the relative insensitivity of state and local spending to changes in GNP. The marginal response of these components to changes in GNP, in other words, has been much smaller than the average response.

TABLE 5. QUARTERLY VALUES OF a_3 a/

	Models					Basic Multipliers Model	
Quarter	1	2	3	4	5	Purchase Change	Tax Change
1	-.07	-.16	.00	-.03	-.23	-.08	-.07
2	.09	-.08	.01	.03	-.02	.01	.00
3	.11	-.05	.03	.07	-.02	.05	.04
4	.10	-.02	.02	.08	-.01	.05	.04
5	.09	-.01	.01	.09	.01	.06	.04
6	.08	-.04	.00	.08	-.06	.07	.05
7	.08	.13	-.01	.07	-.03	.08	.05
8	.08	.17	-.03	.06	-.05	.07	.05
9	.09	.14	-.04	.06	-.05	.06	.03
10	.09	.03	-.05	.06	-.05	.05	.02

a/ Values reported for models 1 through 5 are based on simulations of a change in federal purchases.

THE FISCAL MULTIPLIER FORMULA

The seven equations listed in the basic multipliers model on page 4 can be combined through simple algebra to yield the following multiplier expression for standard changes in fiscal policy:

$$(8)\quad \Delta GNP\$(t) = \frac{1}{[1-(a_{1t}(b_{1t}(1-b_{3t}) - b_{2t}) + a_{2t}+_{3t})]} \Big[\Delta GG\$(t) + \Delta XO\$(t) + a_{1t}\,[\Delta TRO\$(t)-\Delta TPO\$(t)] + [1+a_{1t}(c_{1t}(1-b_{3t}) - c_{2t} + c_{3t})-a_{2t}]\Delta GE\$(t)\Big].$$

The first expression on the right-hand side of the equation is the multiplier for changes in government purchases other than public employment programs. It depends on six of the parameters of the model, namely:

- a_1, the ratio of a change in consumption to a change in disposable income
- a_2, the ratio of a change in investment to a change in GNP
- a_3, the ratio of a change in "other GNP" to a change in GNP
- b_1, the fraction of a change in GNP going into wages and salaries and other labor income and nonwage income
- b_2, the fraction of a change in GNP serving to reduce transfer payments
- b_3, the fraction of a change in wages and salaries and other labor income and nonwage income going into personal tax payments

The government spending multiplier also applies to $\Delta XO\$$, changes in the intercept term of "other GNP;" that is, to exogenous changes in exports, inventory investment, or state and local spending.

The multiplier for shifts in personal taxes and transfers is equal to a_1 times the GNP multiplier, a common result in income-expenditure models.

The multiplier for nondisplaced changes in government employment program spending is a bit more complex. It is equal to the basic government spending multiplier times

$$1+a_{1t}(c_{1t}(1-b_{3t}) - c_{2t}+c_{3t}) -a_{2t}$$

If $c_1 = c_2 = c_3 = 0$, then the expression for the government employment multiplier is slightly less than that for the government purchases multiplier due to the absence of any direct inducement to fixed investment from public employment spending. The two multipliers differ further to the extent that (a) a higher fraction of spending on government employment (higher by c_1) goes into compensation than is the case for changes in the rest of GNP; (b) a higher fraction of spending on government employment (higher by c_2) is offset by a reduction in transfer payments than is the case for other components of GNP; and (c) a lower marginal personal tax rate (lower by c_3) is applicable to government employment income than is the case for the rest of GNP. These deviations can have offsetting effects on the public employment multiplier. A high fraction of spending devoted to compensation, for example, could increase it while targeting at the long-term unemployed could increase the transfer-reduction rate and thereby reduce the size of the multiplier.

Table 6 presents the GNP multipliers derived from the basic multipliers model.

TABLE 6. CHANGE IN GNP RESULTING FROM A PERMANENT INCREMENT IN POLICY INSTRUMENT: IN BILLIONS OF CURRENT DOLLARS FOR EACH BILLION DOLLAR PERMANENT INCREMENT

Quarter	Federal Government Purchases of Goods	Public Service Employment	Federal Taxes or (With Opposite Sign) Transfers
1	1.10	1.15	-.40
2	1.42	1.34	-.63
3	1.79	1.57	-1.09
4	2.00	1.66	-1.07
5	2.22	1.78	-1.27
6	2.41	1.90	-1.43
7	2.62	2.04	-1.64
8	2.71	2.12	-1.77
9	2.66	2.01	-1.74
10	2.53	1.96	-1.64
11	2.44	1.89	-1.57
12	2.44	1.89	-1.57

CHAPTER III. SOME EXTENSIONS OF THE MULTIPLIERS MODEL

The preceding chapter covered standard fiscal policies. The basic model presented there is in fact the one CBO has used for nearly all its policy simulation work. This chapter adds two policy instruments to the basic model--monetary policy and corporate tax rates.

MONETARY POLICY

Parameter estimates used in the basic model are based on policy simulations in which the Federal Reserve Board holds the path of unborrowed reserves constant. The monetary response to an expansionary fiscal move, therefore, cannot include any change in unborrowed reserves, but it can include an increase in the money supply and some (at least temporary) increase in interest rates.

Econometric models differ considerably in their specification of the monetary sector. To highlight these differences, Table 7 presents changes in three-month Treasury bill rates and in GNP occurring in five econometric models as a result of a step increase in unborrowed reserves.

An increase in unborrowed reserves also expands the money supply but (at least temporarily) reduces interest rates. Its effects are, therefore, not a simple multiple of fiscal policy effects, and additional parameters are needed to capture them. This is accomplished by adding an unborrowed reserve term to equations (2), (6), and (7), changing them to:

$$(2)' \quad \Delta C\$(t) = a_{1t}(\Delta INC\$(t) + \Delta TR\$(t) - \Delta TP\$(t)) + d_{1t}\Delta RU\$(t)$$

$$(6)' \quad \Delta FI\$(t) = a_{2t}\Delta GNP\$(t) + d_{2t}\Delta RU\$(t)$$

$$(7)' \quad \Delta X\$(t) = a_{3t}\Delta GNP\$(t) + \Delta XO\$(t) + d_{3t}\Delta RU\$(t).$$

where RU$ = unborrowed reserves.

TABLE 7: CHANGES IN THREE-MONTH TREASURY BILL RATE AND GNP$ IN T-1 RESULTING FROM A STEP INCREASE IN UNBORROWED RESERVES a/

Quarter	Model 1		Model 2		Model 3		Model 4		Model 5	
	Rate	GNP	Rate	GNP	Rate	GNP	Rate	GNP	Rate	GNP
1	-.98	3.4	-.60	.3	-.13	0	-.6	.5	-1.26	.1
2	-1.06	5.4	-.42	.9	-.13	2.5	-.8	1.8	-1.24	3.7
3	-1.08	13.3	-.45	1.9	-.12	4.8	-.8	4.2	-.97	6.8
4	-1.05	19.8	-.45	3.3	-.12	4.9	-.8	7.4	-.97	10.0
5	-.96	25.5	-.44	5.0	-.11	5.5	-.7	11.4	-.83	14.2
6	-.83	30.0	-.42	6.9	-.09	4.2	-.7	15.8	-.65	16.4
7	-.73	33.2	-.39	9.4	-.08	4.2	-.6	20.9	-.54	20.8
8	-.61	34.8	-.35	12.5	-.08	4.3	-.5	26.9	-.33	24.9
9	-.51	35.2	-.33	13.7	-.09	4.1	-.5	33.6	-.29	28.2
10	-.45	34.2	-.32	13.0	-.10	3.7	-.4	40.9	-.17	31.3

a/ All models were simulated for a $1 billion step increase in unborrowed reserves. Bill rate differences from baseline are reported in percentage points. GNP differences from baseline are reported in billions of dollars.

The parameters d_1, d_2, and d_3 measure the direct spending changes that result from a change in unborrowed reserves, holding government spending and transfer and tax rates constant. In equation (2)′, d_1 represents the ratio of additional consumption spending (above the fiscal policy-derived response to disposable income) to changes in unborrowed reserves. This additional consumption arises from wealth and interest rate effects. Similarly, d_2 and d_3--the ratio of changes in fixed investment and

"other GNP," respectively, to changes in unborrowed reserves--reflect the effects on capital spending, inventory investment, and state and local spending of wealth and interest rate changes. 1/

1/ A simple model may clarify the relation of equations (2)′, (6)′, and (7)′ to business and household behavior. Suppose that investment (I) depends on income (Y) and an interest rate (R),

$$I = a_1 + a_2 Y - a_3 R \qquad a_2, a_3 > 0$$

that money (M) demanded also depends on income and interest rates,

$$M = b_1 Y - b_2 R \qquad b_1, b_2 > 0$$

and that money supplied depends on unborrowed reserves (RU) and interest rates.

$$M = c_1 RU + c_2 R$$

Eliminating M and solving for R by combining the second and third equations gives

$$R = \left(\frac{b_1}{b_2 + c_2}\right) Y - \left(\frac{c_1}{b_2 + c_2}\right) RU$$

Substituting this expression for R into the first equation gives

$$I = a_1 + \left(a_2 - \frac{a_3 b_1}{b_2 + c_2}\right) Y + \left(\frac{a_3 c_1}{b_2 + c_2}\right) RU$$

Equation (6)′ above resembles this equation. The coefficient of income reflects both accelerator effects and crowding-out or interest rate effects, while the coefficient of unborrowed reserves reflects interest rate effects and the money-supply and money-demand linkages between unborrowed reserves and interest rates.

To estimate d_1, d_2, and d_3 the values of the a's from fiscal policy simulations are used to deduct from total changes in C, FI, or X the amounts due to income or GNP changes.

Substituting (2)', (6)', and (7)' into the basic multipliers model yields the following unborrowed reserve GNP multiplier:

$$(9) \quad \Delta GNP\$(t) = \frac{[(d_1+d_2+d_3)\Delta RU\$(t)]}{[1-(a_{1t}(b_{1t}(1-b_{3t})-b_{2t})+a_{2t}+a_{3t})]} + [\text{Fiscal Multiplier}]$$

The denominator on the right-hand side of equation (9) is the same as the denominator of a simple government purchases multiplier. The numerator represents the total direct GNP increment originating from a change in unborrowed reserves.

Estimates of d_1, d_2, and d_3 vary significantly across econometric models. Differences exist not only in the level of each parameter (d_2 in the tenth quarter is 13.4 in one model and 0.32 in another) but also in the relative size of d_1, d_2, and d_3 (in one model d_2 is greatest and d_1 is smallest whereas in another the reverse occurs). Not having any prior information on the size of these parameters, CBO used a simple averaging procedure to estimate d_1, d_2, and d_3 for the multipliers model. Table 8 presents these estimates as well as the range of each parameter provided by the five econometric models.

Estimates of b_1 also differed between an unborrowed reserve simulation and a fiscal policy simulation. This difference arises from the contrasting interest rate paths in the two simulations, a contrast which affects corporate profits and personal interest income. The parameter values for b_1 used in simulating monetary policy changes are presented in Table 8, and Table 9 presents the resulting unborrowed reserve multiplier values.

Unborrowed reserve multiplier values grow from 1.0 in the initial quarter to over 25 by the end of three years, as shown in Table 9. Even 25, however, is only about half of the average ratio of GNP to unborrowed reserves. GNP in recent quarters has been 5 to 6 times as large as the narrowly defined money supply, which in turn has been about 9 times as large as unborrowed reserves. The multiplier estimates in Table 9 imply that a step increase in unborrowed reserves above a baseline path lowers the velocity of money relative to its baseline path.

TABLE 8. QUARTERLY VALUES OF d_1, d_2, d_3, and b_1

Quarter/ Parameter	d_1			d_2			d_3			b_1		
	Multipliers Model	Range Provided by Econometric Models		Multipliers Model	Range Provided by Econometric Models		Multipliers Model	Range Provided by Econometric Models		Multipliers Model	Range Provided by Econometric Models	
		Low	High		Low	High		Low	High		Low	High
1	.17	.03	.74	.33	.00	1.18	.00	-.33	1.41	.36	-.96	.68
2	.82	1.06	2.81	1.11	.87	2.84	.15	-.84	.80	.51	.00	.70
3	.54	.28	3.38	1.95	1.49	4.40	.55	-.43	1.31	.53	.05	.70
4	1.05	.55	4.48	2.73	1.43	6.00	.87	-.26	2.85	.60	.15	.72
5	1.30	.76	5.97	3.42	1.15	7.50	1.20	-.24	4.02	.62	.24	.74
6	1.70	1.01	6.76	4.18	1.15	9.23	1.26	-.33	4.90	.68	.26	.74
7	2.05	1.05	7.74	4.83	.86	10.54	1.53	-.12	5.47	.70	.26	.76
8	2.38	1.04	8.98	5.56	.62	12.11	1.79	.03	5.83	.70	.26	.77
9	2.64	1.20	9.67	6.01	.37	12.95	2.17	.07	6.46	.71	.28	.78
10	2.85	1.25	10.48	6.43	.32	13.42	2.26	.04	6.26	.73	.29	.78
11	3.00	--	--	6.60	--	--	2.45	--	--	.73	--	--
12	3.00	--	--	6.60	--	--	2.45	--	--	.73	--	--

TABLE 9. CHANGES IN GNP RESULTING FROM A PERMANENT INCREMENT IN UNBORROWED RESERVES: IN BILLIONS OF CURRENT DOLLARS FOR EACH BILLION DOLLAR PERMANENT INCREMENT

Quarter	Multiplier
1	1.00
2	2.86
3	5.12
4	8.77
5	12.10
6	16.17
7	20.29
8	23.80
9	24.83
10	24.88
11	26.15
12	26.15

CORPORATE TAX CHANGES

The extensions needed to measure corporate tax change effects on GNP are procedurally similar to those discussed above for monetary policy. The basic multipliers model does not include dividends, corporate cash flow, or the corporate tax rate as separate determinants of consumption and investment spending and, therefore, cannot account for the effect of changes in corporate taxes on spending. The effect of corporate taxes can be incorporated into the basic model by changing equations (2), (3), (5), and (6) to:

$$(2)'' \quad \Delta C\$(t) = a_{1t}\,(\Delta INC\$(t) + \Delta TR\$(t) - \Delta TP\$(t)) + d_{1t}\Delta RU\$(t) + g_{1t}\,\Delta BUSTAX\$(t)$$

$$(3)'' \quad \Delta INC\$(t) = b_{1t}\Delta GNP\$(t) + c_{1t}\Delta GE\$(t) - g_{2t}\Delta BUSTAX\$(t)$$

$$(5)'' \quad \Delta TP\$(t) = b_{3t}\Delta INC\$(t) - c_{3t}\Delta GE\$(t) + \Delta TPO\$(t) - c_{4t}\,\Delta BUSTAX\$(t)$$

$$(6)'' \quad \Delta FI(t) = a_{2t}\,\Delta GNP\$(t) + d_2\,\Delta RU\$(t) - g_{3t}\,\Delta BUSTAX\$(t).$$

In equation (2)", g_{1t} is the proportion of the business tax change going into consumption. Equations (3)", (5)", and (6)" allow for departures from the standard fiscal-policy-induced relationships explaining personal income, personal taxes, and fixed investment.

Parameter values from econometric models were reasonably similar for simulations in which the corporate tax equation intercept was changed. The models varied dramatically, however, in their estimates for a change in corporate tax rate. (A rate change that provides a $10 billion change in corporate taxes leads to a $54 billion addition to GNP in one model and a $5.8 billion reduction in GNP in another.) The econometric models and empirical tax studies were, therefore, used to derive g_1, g_2, g_3, and c_4 only for a lump-sum change in corporate taxes. Results are reported in Table 10. Estimating parameters for changes in corporate tax rates will be undertaken at a later date after CBO studies the differences in the econometric models' simulations more carefully.

TABLE 10. CORPORATE TAX CUT PARAMETERS USED IN THE BASIC MULTIPLIERS MODEL

	Parameters			
Quarter	g_1	g_2	g_3	c_4
1	.00	.02	.00	.00
2	.04	.05	.02	.02
3	.03	.10	.03	.02
4	.02	.13	.08	.03
5	.02	.14	.09	.04
6	.02	.14	.13	.04
7	.01	.14	.15	.04
8	.02	.14	.17	.05
9	.03	.14	.21	.05
10	.03	.08	.24	.05

Substituting these equations into the basic multipliers model generates the following multiplier expression for changes in corporate taxes:

$$GNP\$(t) = \frac{-[g_{1t}+a_{1t}(g_{2t}(1-b_{3t})-c_{4t})+g_{3t}]}{[1-(a_{1t}(b_{1t}(1-b_{3t})-b_{2t})+a_{2t}+a_{3t})]}$$

The denominator of this equation is the denominator of the simple government purchases multiplier. The numerator represents the direct spending induced by a change in corporate taxes. This multiplier is useful in analyzing fiscal policies that directly change corporate cash flow (for example, employment tax credits, and training programs implemented in the private sector). Table 11 presents the multiplier values.

TABLE 11. CHANGES IN GNP RESULTING FROM A PERMANENT INCREMENT IN CORPORATE TAX PAYMENTS: IN BILLIONS OF CURRENT DOLLARS FOR EACH BILLION DOLLAR PERMANENT INCREMENT

Quarter	Multiplier
1	-.01
2	-.09
3	-.16
4	-.27
5	-.35
6	-.48
7	-.56
8	-.62
9	-.76
10	-.70
11	-.65
12	-.65

CHAPTER IV. PRICE CHANGES VERSUS REAL OUTPUT CHANGES

Although CBO uses a two-equation, wage-price model to divide changes in nominal GNP between prices and real output, it is easy and interesting to compare a number of models with respect to their output and price effects. The differences among models arise in large part from differences in labor market specifications and productivity behavior.

Table 12 shows the division of two key components, a_1 (the ratio of changes in consumption to changes in GNP) and a_2 (the ratio of changes in fixed investment to changes in GNP) into quantity and price effects implied by each econometric model. The division is based on the formula

$$\Delta(p_t q_t) = p_{t-1}(\Delta q_t) + q_t(\Delta p_t)$$

where q is a quantity (or constant-dollar value) and p is a price index (or deflator). The first term on the right-hand side shows the contributions of quantity change to the total dollar change, while the second shows the contribution of price change. To factor a ratio such as a_1 into quantity and price effects, each term in the formula is divided by the dollar change in the denominator of the ratio; thus, for factoring a_1, q in the formula refers to constant-dollar consumption, p to the consumption deflator, and each term is divided by the current-dollar change in disposable income.

TABLE 12. DIVISION OF GOVERNMENT PURCHASES GNP$ MULTIPLIER, a_1, AND a_2 INTO REAL AND NOMINAL PRICE EFFECTS FOR SELECTED QUARTERS FOR FOUR ECONOMETRIC MODELS

ΔGNP$(t)/ΔGG$(t)

	Model 1			Model 2			Model 3			Model 4		
Quarter	Real	Price	Multiplier	Real	Price	Multiplier	Real	Price	Multiplier	Real	Price	Multiplier
1	1.2	0.0	1.2	0.9	0.0	1.0	1.1	0.1	1.2	1.0	0.1	1.1
4	2.1	0.2	2.3	1.4	0.0	1.4	1.5	0.2	1.6	1.6	0.5	2.1
7	1.9	0.4	2.4	1.1	1.4	2.5	1.3	0.4	1.7	1.9	1.1	3.0
10	1.6	0.8	2.4	0.3	1.5	1.8	1.0	0.6	1.6	1.7	1.9	3.6

ΔC$(t)/ΔDisposable Income

	Model 1			Model 2			Model 3			Model 4		
Quarter	Real	Price	a_1	Real	Price	a_1	Real	Price	a_1	Real	Price	a_1
1	.42	-.02	.41	.24	.02	.26	.50	.05	.55	.17	.08	.25
4	.66	.05	.71	.32	-.02	.30	.60	.05	.65	.21	.30	.51
7	.58	.15	.73	-.02	.71	.69	.47	.22	.69	.21	.44	.65
10	.45	.26	.71	-.18	.85	.67	.29	.42	.70	.16	.60	.76

ΔFI$(t)/ΔGNP$(t)

	Model 1			Model 2			Model 3			Model 4		
Quarter	Real	Price	a_2	Real	Price	a_2	Real	Price	a_2	Real	Price	a_2
1	.01	.00	.02	.08	.00	.07	.02	.00	.03	.05	-.02	.04
4	.04	.01	.05	.21	.00	.21	.07	.02	.09	.17	-.01	.16
7	.02	.03	.05	.10	.14	.23	.01	.03	.04	.16	.02	.18
10	-.03	.05	.03	-.11	.18	.06	-.06	.06	-.01	.12	.04	.16

NOTE: Real and nominal do not necessarily sum to actual parameter value due to rounding errors. Both a_1 and a_2 are estimated from a government purchases policy simulation.

CHAPTER V. OTHER RELATIONSHIPS USED IN MEASURING POLICY IMPACTS

The multipliers model described above provides nominal GNP changes resulting from changes in fiscal and monetary policies. Additional relationships are used to measure the impact of policy changes on real GNP, prices, employment, and other economic variables of interest. While this paper is concerned primarily with nominal GNP multipliers, a brief description of the other relationships used by CBO may be helpful.

Figure 1 presents a flow diagram of the relationships used to translate a change in economic policy into a change in nominal GNP and other economic variables. The first step is the conversion of policy changes into nominal GNP changes, using the multipliers described in this paper.

Next, employment and unemployment changes resulting from a policy change are derived from an Okun's law type of relationship between unemployment and the real GNP gap, lagged one quarter. If a policy has a direct impact on employment beyond that implied by Okun's law, a procedure is used (described in the next paragraph) that accounts for this differential. A two-equation, wage-price 1/ model and a CPI-GNP deflator relationship are then used to derive a GNP deflator consistent with the unemployment rate. The deflator, together with the level of nominal GNP, determines real GNP. The new real GNP gap determines the next period's unemployment.

Direct employment programs can (but do not necessarily) create more jobs per dollar spent than conventional fiscal policy changes. The reasons are twofold: (1) direct employment programs may entail less "slippage" in restoring productivity and profits and increasing the average hours of existing jobholders; and (2) direct employment programs may pay a relatively low average wage. The first step in CBO's procedure

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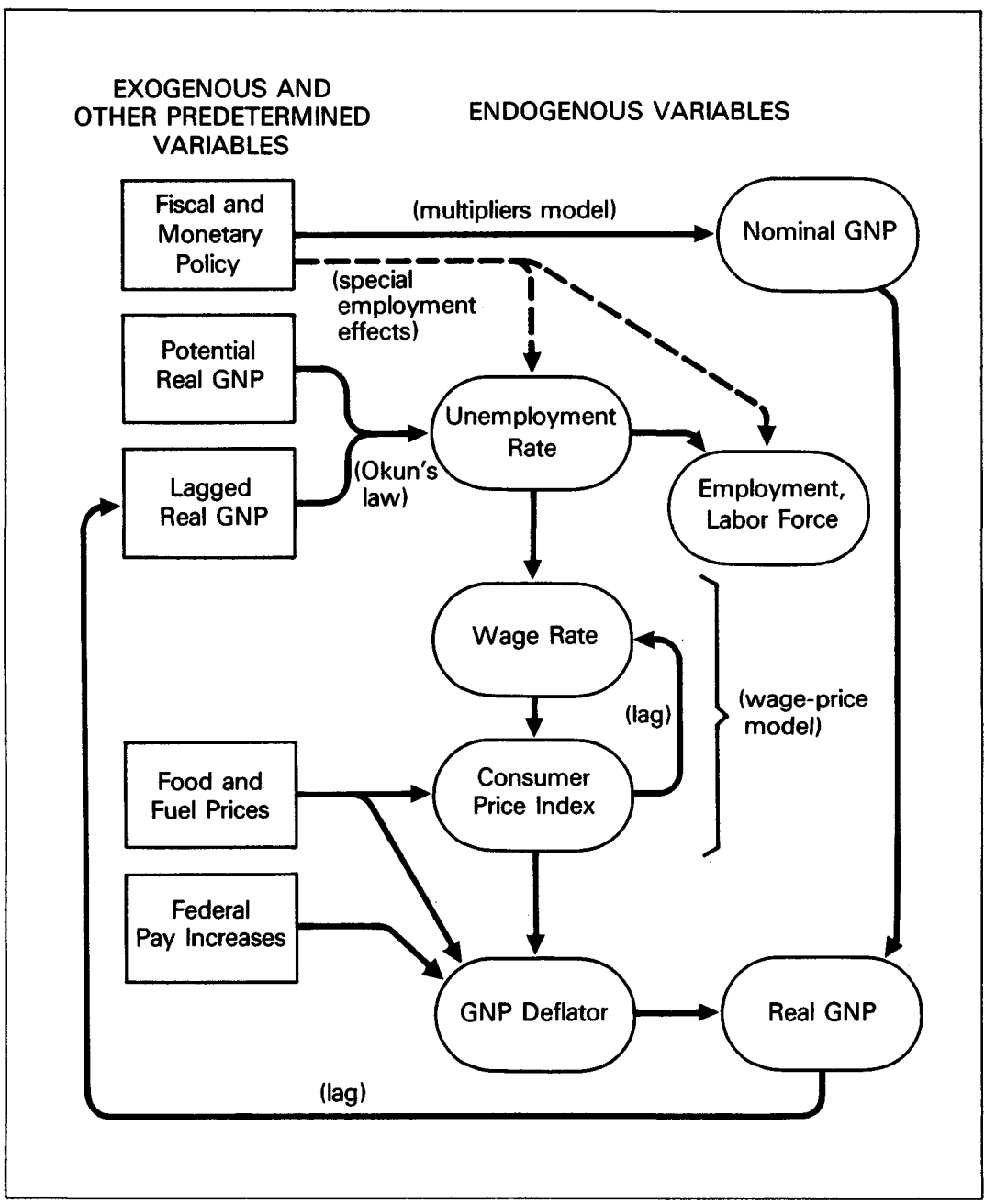
1/ See "A Simplified Wage-Price Model," available from the Fiscal Analysis Division, Congressional Budget Office (September 1975).

Figure 1.

MEASURING POLICY IMPACTS



for estimating the job impact of a direct employment program reflecting these special features is to estimate the nondisplaced outlays quarter by quarter, and divide these outlays by an estimate of average cost per job. This provides an estimate of the direct jobs created by a public employment program.

The next step is to calculate an estimate of the indirect unemployment and employment impact of the policy using GNP multipliers and Okun's law. The indirect impact arises from two sources: additional spending induced by the nondisplaced outlays, and the use of displaced funds for tax reduction and/or increased purchases. The "indirect" GNP multiplier for the first source, nondisplaced outlays, is equivalent to the overall public employment multiplier, dealt with explicitly in this paper, less one. The GNP multiplier for displaced outlays is a weighted combination of the government purchases multiplier and the personal tax multiplier. The weights CBO used are based on the views of experts about how state and local governments use general revenue sharing funds. The overall multiplier of a direct employment program is thus a combination of the multipliers described in this paper.

The final step in calculating overall job impacts is to add the direct effects from step one to the indirect effects from step two.

As the example of direct employment programs makes clear, it is possible to use the multipliers framework to introduce explicitly a wide range of special assumptions about fiscal policy changes, including assumptions about the timing of outlays, fiscal substitution, average cost per job, proportions of grants-in-aid going to tax relief, and others. Typically it is much more difficult to incorporate many of these assumptions in large-scale econometric models. The multipliers model thus has the advantage of introducing clear links between program details and economic effects.

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