POLICY COMPLEMENTARITY AND CONFLICT IN REGIONALLY
DISAGGREGATED MACROECONOMIC MODELS:
AN EXAMPLE FROM THE BRAZILIAN EXPERIENCE

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ABSTRACT

In this paper, the interrelated nature of the growth and regional inequality goals is examined. Then we analyse the interdependencies between simultaneous pursuit of national growth and regional equality, and the possible complementarity or conflicting results of exogenous events and macroeconomic policies toward those ends. These interdependencies are illustrated through the use of a simple two-region aggregated demand model. As an application of the previous analysis a case study of Brazil's experience during the 1960's and 1970's is presented.

RESUMO

Neste trabalho examinamos a natureza interdependente entre as metas de crescimento econômico e desigualdade regional. Estudamos a possível complementaridade ou conflito de eventos exógenos e de políticas macroeconômicas que busquem tais metas. Nesse sentido, ilustramos a discussão com um modelo simples de demanda agregada para duas regiões. Completamos a análise com um estudo do caso referente à experiência brasileira dos anos de 60 e 70.

I. INTRODUCTION

National policy goals throughout the world typically include the promotion of economic growth and the reduction of domestic regional inequalities. Even though neoclassical regional growth models indicate that regional per capita incomes will converge in the long run due to factor migration and that equilibrium growth rates are basically limited by population growth rates, many governments are either doubtful of these conclusions or unwilling (or unable) to wait for the long-run convergence of regional incomes and the achievement of equilibrium growth. As a result policies are adopted to both promote national growth and to alleviate the regional inequities which exist. Unfortunately, the economic models used to analyze these problems and to develop policies to correct them often neglect the basic interrelationships between the national and regional policies and circumstances. This neglect often leads to the adoption of policies which are conflicting, rather than complementary, with respect to the policy goals.

In this paper, the interrelated nature of the growth and regional inequality goals is examined in section II. Then, the interdependencies between simultaneous pursuit of national growth and regional equality, and the possible complementary or conflicting results of exogenous events and macroeconomic policies toward those ends are analyzed in section III. These interdependencies are discussed and illustrated through the use of a simple two-region aggregate demand model. As an application of the previous analysis, a case study of Brazil's experience during the 1960's and 1970's is presented in section IV.

II. NATIONAL GROWTH AND REGIONAL INEQUALITY: THE BASIC INTERDEPENDENCY

To illustrate the relationship between national growth and regional inequality a general case of n regions could be considered; however, to simplify the exposition, assume two regions (A and B)

where region A is poorer than region B. To further simplify the argument, assume either that the population growth rates for both regions and the nation are the same, or that total rather than per capita income is the appropriate measure for judging regional inequality and national growth¹. In addition assume that the policy goals of the government are to promote high national growth rates or, alternatively, large proportional changes in national income and to reduce the inequality between the two regions².

To formally develop the interdependency between these two goals, define the following variables:

$Y = Y_a + Y_b = \text{national income};$

$Y_a (Y_b) = \text{region A's (B's) income};$

$\alpha/(1 - \alpha) = Y_a/Y (Y_b/Y) = \text{region A's (B's) share of national income}; \text{ and}$

$R = Y_a/Y_b = \text{the measure of regional inequality, } R < 1 \text{ by assumption.}$

Letting a circumflex over a variable indicate the proportional change or growth rate of a variable, the proportional change in national income (Y) and in the measure of regional inequality (R) are

$$\hat{Y} = \alpha \hat{Y}_a + (1 - \alpha) \hat{Y}_b \quad (1)$$

$$\text{and } \hat{R} = \hat{Y}_a - \hat{Y}_b. \quad (2)$$

Verbally, these relationships show that the national growth rate is a weighted average of the regional growth rates, while changes in the measure of regional inequality are determined by the difference between the growth rates. It is now possible to identify how conflicts between the two policy objectives may arise. Reduction of regional inequality requires that R move toward 1, implying that $\hat{Y}_a > \hat{Y}_b$ is necessary for a reduction of regional inequality³. A high national growth rate is most easily attained, however, by greater growth in region B since the weight on region B's growth rate $(1 - \alpha)$ is greater than the weight on region A's growth

rate (α). Thus, there is a trade-off between the ease of achieving any given national growth rate and the reduction of regional inequality; however, it is still clearly possible to satisfy both goals.

III. POLICY CONFLICT OR COMPLEMENTARITY

Conceptually it is clear how different policies can be in conflict or be complementary with respect to achieving the goals of stimulating national growth and reducing regional inequality. To generate the largest effects on national growth for a given effort, policies should be biased towards region B. Such a policy bias, however, would most likely lead to a worsening of regional inequality, unless the cross-regional effects from B to A are very strong. In other words, the curve relating the possible combinations of national growth and improvements in regional equity may have either a positive or negative slope depending upon the regional economies' structures and the economics policy mix chosen.

To formally develop this idea a basic model of how policy measures affect the levels of regional income is needed. To satisfy this need and to provide the basic theoretical underpinnings for the analysis of Brazil's policies presented in the next section, a two region aggregate demand model is developed and analyzed in this section. The model is composed of four equations for each region: an aggregate regional expenditures function; an interregional import function; an interregional trade equilibrium condition; and a regional income equilibrium condition. Aggregate regional expenditures (E) in each region are composed of consumption, investment and government expenditures plus net foreign exports; these expenditures are a function of both regions' income (Y_a, Y_b), region specific exogenous and policy variables ($Z_{ik}; i=a,b; k=1,2,\dots,m$), and national exogenous and policy variables ($Z_h; h=1,2,\dots,n$). Interregional imports ($M_i; i=a,b$) are a function of each region's income. The interregional trade equilibrium conditions state that each region's regional exports ($X_i; i=a,b$) must equal the regional

imports of the other region; while the regional income equilibrium conditions simply state that each region's income must be equal to the sum of that region's aggregate regional expenditures and net-interregional exports. Thus, the model's eight structural equations are as follows⁴:

Aggregate Regional Expenditure Functions:

$$E_a = E_a(Y_a, Y_b, Z_{a1}, Z_{a2}, \dots, Z_{am}, Z_1, Z_2, \dots, Z_n) \quad (3.a)$$

$$E_b = E_b(Y_b, Y_a, Z_{b1}, Z_{b2}, \dots, Z_{bm}, Z_1, Z_2, \dots, Z_n) \quad (3.b)$$

$$E_{i1} = \partial E_i / \partial Y_i > 0; E_{i2} = \partial E_i / \partial Y_j > 0; E_{i1} + E_{j2} < 1; i \neq j;$$

$$E_{i2+k} = \partial E_i / \partial Z_{ik} \geq 0$$

$$E_{i2+m+h} = \partial E_i / \partial Z_h \geq 0$$

Interregional Import Functions:

$$M_a = M_a(Y_a) \quad (4.a)$$

$$M_b = M_b(Y_b) \quad (4.b)$$

$$M_i' = dM_i/dY_i > 0$$

Interregional Trade Equilibrium Conditions:

$$X_a = M_b \quad (5.a)$$

$$X_b = M_a \quad (5.b)$$

Regional Income Equilibrium Conditions:

$$Y_a = E_a + X_a - M_a \quad (6.a)$$

$$Y_b = E_b + X_b - M_b \quad (6.b)$$

Substitution of equations 3, 4, and 5 into equations 6 and solving for the proportional change (growth rate) of the regional incomes ($\dot{Y}_a$, $\dot{Y}_b$) in terms of the proportional changes of the exogenous and policy variables ($\dot{Z}_{ak}$, $\dot{Z}_{bk}$, $\dot{Z}_h$) yields:

$$Y_a = (F/D) \sum_{k=1}^m \phi_k E_{a_{2+k}} \hat{z}_{ak} + (I/RD) \sum_{k=1}^m \psi_k E_{b_{2+k}} \hat{z}_{bk} \\ + \frac{1+R}{RD} \sum_{h=1}^n \{F E_{a_{2+m+h}} + I E_{b_{2+m+h}}\} \theta_h \hat{z}_h \quad (7.a)$$

$$\text{and } \hat{Y}_b = (RK/D) \sum_{k=1}^m \phi_k E_{a_{2+k}} \hat{z}_{ak} + (H/D) \sum_{k=1}^m \psi_k E_{b_{2+k}} \hat{z}_{bk} \\ + \frac{1+R}{D} \sum_{h=1}^n \{K E_{a_{2+m+h}} + H E_{b_{2+m+h}}\} \theta_h \hat{z}_h \quad (7.b)$$

where

$$D = HF - IK > 0 \quad K = E_{b_2} + Ma' > 0$$

$$H = 1 - E_{a_1} + Ma' > 0 \quad \phi_k = Z_{ak}/Y_a$$

$$I = E_{a_2} + Mb' > 0 \quad \psi_k = Z_{bk}/Y_b$$

$$F = 1 - E_{b_1} + Mb' > 0 \quad \theta_h = Z_h/Y.$$

Substitution of equations 7 into equations 1 and 2 results in the following expressions for the national growth rate and the percentage change in regional inequality in terms of the exogenous and policy variables:

$$\hat{Y} = \frac{R}{1+R} \frac{F+K}{D} \sum_{k=1}^m \phi_k E_{a_{2+k}} \hat{z}_{ak} + \frac{1}{1+R} \frac{I+H}{D} \sum_{k=1}^m \psi_k E_{b_{2+k}} \hat{z}_{bk} \\ + \frac{1}{1+R} \sum_{h=1}^n \{(F+K) E_{a_{2+m+h}} + (I+H) E_{b_{2+m+h}}\} \frac{\theta_h}{D} \hat{z}_h \quad (8)$$

and

$$\hat{R} = \frac{F-RK}{D} \sum_{k=1}^m \phi_k E_{a_{2+k}} \hat{z}_{ak} + \frac{I-RH}{RD} \sum_{k=1}^m \psi_k E_{b_{2+k}} \hat{z}_{bk} \\ + \frac{1+R}{RD} \sum_{h=1}^n \{(F-RK) E_{a_{2+m+h}} + (I-RH) E_{b_{2+m+h}}\} \theta_h \hat{z}_h. \quad (9)$$

Equations 8 and 9 form the basis for the analysis of whether a given policy or exogenous change generates effects which are complementary or in conflict with respect to the policy goals. The coefficients of the exogenous and policy variables in these equations show the contribution of a one percent change in these variables to the national growth rate and the proportional change of regional inequality, respectively. Assume $\hat{z}_{ak}$, $\hat{z}_{bk}$ and $\hat{z}_h$ all have values which contribute positively to national growth. Division of the coefficient of each independent variable in equation 9 by the corresponding coefficient in equation 8 gives the following expressions for the "Complementarity-Conflict Ratio" for each set of exogenous/policy variables:

$$CCRa = \frac{1 + R}{R} \frac{F - RK}{F + K} \text{ for the Region A specific variables;}$$

$$CCRb = \frac{1 + R}{R} \frac{I - RH}{I + H} \text{ for the Region B specific variables; and}$$

$$CCR_h = h(CCRa) + (1 - \Omega_h)(CCRb) \text{ for the } h\text{th national variable;}$$

where

$$\Omega_h = \frac{F + K}{(F + K) + (I + H)\omega_h}$$

and

$$\omega_h = (Eb_{2+m+h}) / (Ea_{2+m+h}).$$

If these Complementarity-Conflict Ratios have the value x , then a change producing a one percent increase in national income would also produce an $x\%$ change in regional inequality. The sign of these ratios indicates whether a given exogenous or policy change produces complementary or conflicting effects with regard to the stated policy goals, while the size of the ratios indicates the intensity of their effects. If the ratio is negative, then changes in the respective policy variables produce conflicting effects on national growth and regional inequality, while a positive value for the ratio indicates complementary effects. The larger the absolute value of the ratio, the greater the effect (either positive or negative) on regional inequality for a given change in the national growth rate.

Even though these Complementarity-Conflict Ratios can be used to identify whether individual independent variable changes generate complementary or conflicting effects with respect to the policy goals, they are not sufficient for the analysis of the complete policy vector. To determine if a given policy vector generates complementary or conflicting effects the following Total or Aggregate Complementarity-Conflict Ratio (CCRT) must be used⁵:

$$CCRT = \frac{\Delta a}{\Delta} CCRA + \frac{\Delta b}{\Delta} CCRb + \frac{\Delta N}{\Delta} \sum_{h=1}^n \chi^h CCRh$$

where

$$\Delta = \hat{Y} = \text{equation 8;}$$

$$\Delta a = \hat{Y} | \hat{Z}_a = \frac{R}{1+R} \frac{F+K}{D} \sum_{k=1}^m \phi_k E_{a_{2+k}} \hat{Z}_{ak}$$

= the percentage change in national income due to region A's policy changes;

$$\Delta b = \hat{Y} | \hat{Z}_b = \frac{1}{1+R} \frac{I+H}{D} \sum_{k=1}^m \psi_k E_{b_{2+k}} \hat{Z}_{bk}$$

= the percentage change in national income due to region B's policy changes;

$$\Delta N = \hat{Y} | \hat{Z} = \sum_{h=1}^n \{ (F+K) E_{a_{2+m+h}} + (I+H) E_{b_{2+m+h}} \} \frac{\Theta h}{D} \hat{Z}_h$$

= the percentage change in national income due to national policy changes;

$$\chi^h = \hat{Y} | \hat{Z}_h / \Delta N = \{ (F+K) E_{a_{2+m+h}} + (I+H) E_{b_{2+m+h}} \} (\Theta h / D) \hat{Z}_h / \Delta N$$

= national policy variable h's relative contribution to the total percentage change in national income due to national policy changes;

$$1 = \frac{\Delta a}{\Delta} + \frac{\Delta b}{\Delta} + \frac{\Delta N}{\Delta}; \text{ and}$$

$$\sum_{h=1}^n \chi^h = 1.$$

The Total or Aggregate Complementarity-Conflict Ratio is a weighted average of the regional and national policy complementarity-conflict ratios where the weights used are the relative contributions of each set of policies to the total percentage change in national income, and is interpreted in the same manner as the individual Complementarity-Conflict Ratios.

IV. POLICY CONFLICT AND COMPLEMENTARITY: THE BRAZILIAN EXPERIENCE

The ideas developed in the last section regarding policy conflict or complementarity are applied to the case of Brazil in this section. As is well documented in the literature dealing with Brazil's economic development, Brazil has had severe regional imbalances and a generally successful growth experience over the past fifteen years⁶. It has also been recognized that many of the policies adopted to promote national growth may have had adverse effects on the regional problem⁷.

The model used to evaluate the effects of Brazil's economic policies on growth and regional inequality is analogous to the model presented in the last section⁸. Region A is the Brazilian Northeast and Region B is the rest-of-Brazil. The structural equations underlying the regional expenditure functions follow the standard Keynesian formulations except for the inclusion of Brazil's export and fiscal incentive systems⁹. Table 1 lists the model's exogenous and policy variables, while Table 2 presents the estimated parameter values.

Our analysis divides the 1965 to 1980 period into five subperiods which are determined by the availability of consistent data, Brazil's economic performance, and an attempt to use time periods of equal length. Consistent macroeconomic data are available from 1965 through 1980 (data for certain variables are not available after 1977). With the exception of two subperiods, three year in-

tervals have been used. The 1965-67 subperiod is the latter part of the military stabilization period marked by relatively slow economic growth. The four-year subperiod of 1970-74 is the latter half of the high growth period commonly known as the "Brazilian Miracle".

Table 3 presents the values of the Complementarity-Conflict Ratios for each of the five subperiods. The classification of the exogenous and policy variables by whether they generate complementary or conflicting effects and by the relative intensity of their effects (Table 4) shows that there are four variables which generated complementary effects in all time periods (N_a , ζ , λ , W), three variables which generated conflicting effects in all time periods (N_b , e , γ), and three variables whose effects switch from being conflicting to complementary as regional inequality worsened in the late 1960's and 1970's (ε , YF , G). Further, the ranking of the intensities of the independent variables' effects from "most complementary" (highest CCR) to "most conflicting" (lowest CCR) remains constant throughout the time period.

The effects of the policy vector are analyzed in Table 5. Rather than discuss each independent variable, their effects have been grouped together according to their "type" (Exogenous, Exogenous/Policy, of Policy) as identified in Table 2. Examination of the CCRT values shows that the net effect of the policy vector was complementary in three of the five subperiods (1965-67, 1970-74, and 1974-77), while it was conflicting in two subperiods (1967-70 and 1977-80). Except for the 1965-67 period, however, the intensity of both the complementary and conflicting effects have been relatively low as indicated by the small absolute CCRT values. From 1967 through 1980, the largest absolute CCRT is 0.612 which tells us that a 0.6% change in the ratio of Region A's income to Region B's income resulted for each 1.0% of induced growth.

Using equation 8, the contribution of each group of independent variables to Brazil's growth was calculated. The results show that throughout the fifteen years being examined the major impetus to growth came from the exogenous variable (U.S. income) which accounts for at least ninety percent (90%) of the induced growth. On

the other hand the growth effects of the policy variables, when positive, were responsible for a relatively small portion of the total growth¹⁰. From 1967 to 1970 the policy variables accounted for 16.4% of Brazil's growth, while the changes in U.S. income accounted for 97.5% of that growth and the mixed policy/exogenous variables made a negative contribution of 13.9%. During the 1977-80 subperiod U.S. income was responsible for almost 92% of the induced growth while the policy variables accounted for approximately 8% of this growth.

The independent variables's relative contributions to the Aggregate Complementarity-Conflict Ratios have been the opposite of their relative contributions to national growth. The policy variables account for the greatest portion of the observed CCRT values. Excepting the 1974-77 subperiod when the policy variables account for only 61% of the CCRT value, these variables have been responsible for more than 82% of the observed CCRT values.

Since the policy variables have had a relatively small effect on national growth, it is reasonable to ask if they have had favorable impacts on regional inequality. As is clear from the last portion of Table 5, in the periods when these policies were contractionary with respect to growth (1965-67, 1970-74, and 1974-77), they improved the regional distribution; the opposite is true, however, for the periods of net expansionary policy (1967-70 and 1977-80). During the 1965-67 stabilization period, the policy variables acted to offset the negative influence on regional distribution of the exogenous variables, but had the same effects on this distribution as the exogenous variables from 1968 through 1977. After 1977 the policy variables' effects again ran counter to those of the exogenous variables, thus acting to worsen regional inequality.

The result that Brazil's domestic policies have made relatively small contributions to her induced growth, while the contribution of foreigner income has been large, may be viewed by some as surprising. The information in Table 6 provides the basis for explaining this result. The top half of Table 6 shows the percentage change of the exogenous and policy variables, while the bottom half

gives the value of their coefficients in equation 8. Together, the se items determine the variables's absolute contribution to induced growth.

The principal reason for the large contribution of foreign income (YF) to Brazil's growth is the size of its growth rate coefficient, ranging from 625 in the 1965-67 period to 335 in the 1977-80 period. These coefficients are at least six times, and up to fourteen times, as large as the maximum growth rate coefficient for the policy variables. Thus, despite the relatively small percentage changes in foreign income, its contribution to Brazil's growth has been substantial.

The policy variables's relatively small contribution to induced growth comes from two sources. First, their growth rate coefficients are relatively small. Second, and most importantly, the policies have been contradictory in terms of their effects on growth. As is clear from Table 6, the devaluations of the nominal exchange rate under the governments' crawling-peg policy resulted in a revaluation of the real exchange rate in the 1965-67, 1970-74, and 1974-77 periods. Given the large, positive values of the real exchange rate's growth rate coefficient, these revaluations generated substantial contractionary effects, offsetting the expansionary nature of the other policies.

The conclusion to be drawn from the above analysis is that the Brazilian authorities have had very little success at coordinating their policy mix to both stimulate growth and improve the regional distribution of the national product. The major contributing factor to Brazilian growth over these fifteen years has been the favorable growth performance of the United States which is totally outside the control of Brazil's macro-policymakers. For the subperiods when Brazil's macro-policy has had net stimulative effects on the economy, it has had negative effects on regional distribution, while the reverse has been true for the periods when there were net contractionary effects from the macro-policies. Thus, at least for this fifteen year period, the slope of the curve showing the possible combinations of national growth and regional distribution has been negative.

Table 1

EXOGENOUS AND POLICY VARIABLES FOR THE BRAZILIAN MODEL

VARIABLE	VARIABLE INDEX	TYPE OF VARIABLE*
Northeast's Aggregate Incentive Investment Multiplier (Na)	Za1	Policy/Exogenous
Rest-of-Brazil's Aggregate Incentive Investment Multiplier (Nb)	Zb1	Policy/Exogenous
Foreign Income (YF)	Z1	Exogenous
Exchange Rate (e)	Z2	Policy
Export Subsidy Rate (ϵ)	Z3	Policy
Government Expenditures (G)	Z4	Policy
Northeast's Share of Government Expenditures (γ)	Z5	Policy
Private to Incentive-Induced Investment Ratio (λ)	Z6	Policy/Exogenous
Northeast's Share of Disbursed Fiscal Incentive Funds (ζ)	Z7	Policy/Exogenous
Fraction of Incentive Funds Retained per Time Period (ω)	Z8	Policy/Exogenous

(*) The variables labelled "Policy/Exogenous" are neither purely policy nor purely exogenous variables since they are determined both by policy actions and by other exogenous forces, hence the combined classification.

Table 2

PARAMETER ESTIMATES FOR THE BRAZILIAN MODEL*+

PARAMETER	DERIVATIVE WITH RESPECT TO:	REGION A (NORTHEAST)	REGION B (REST-OF-BRAZIL)
Ei_1	Y_i	0.7490	0.7991
Ei_2	Y_j	0.640	0.0681
Ei_3/Z	N_i	10.0443	10.9557
Ei_4	YF	1751.0	13310.0
Ei_5	e	-667500.0	1018100.0
Ei_6	ϵ	63374.0	423645.0
Ei_7	G	0.05	0.95
Ei_8/G	γ	1.0	-1.0
Ei_9/Z	λ	0.2343	0.4051
Ei_{10}/Z	ζ	10.2879	16.3065
$Ei_{11}/(t-1)$	W	4.9207	8.5071
Mi'	Y_i	0.5680	0.0065

(*) Average values. Foreign (United States) income was measured in billions of dollars, while Brazil's aggregate values were measured in millions of cruzeiros. For converting nominal to real terms, the implicit GNP deflators with 1970 as the base year were used.

+ These estimates are based upon annual data and were found using the Three - Stage Least Squares estimation procedure.

Source: Harber (1982a).

Table 3

COMPLEMENTARITY-CONFLICT RATIOS FOR THE BRAZILIAN MODEL

	TIME PERIODS				
	1965-67	1967-70	1970-74	1974-77	1977-80
CCRa (Na)	1.640	1.520	1.757	2.113	2.042
CCRb (Nb)	- 0.224	- 0.266	- 0.183	- 0.058	- 0.083
CCR1 (YF)	- 0.017	- 0.068	0.033	0.182	0.153
CCR2 (e)	- 3.287	- 3.203	- 3.370	- 3.628	- 3.576
CCR3 (ε)	-----	- 0.045	0.058	0.211	0.181
CCR4 (G)	- 0.135	- 0.182	- 0.090	0.045	0.018
CCR5 (Y)	-34.397	-33.025	-35.740	-39.877	-39.053
CCR6 (λ)	0.436	0.366	0.504	0.711	0.670
CCR7 (ζ)	0.474	0.402	0.543	0.754	0.713
CCR8 (W)	0.436	0.366	0.504	0.711	0.670

Table 4

RANKING OF COMPLEMENTARITY-CONFLICT RATIOS
FROM "MOST COMPLEMENTARY" TO "MOST CONFLICTING"

Time Period	COMPLEMENTARY INDEPENDENT VARIABLES CCR > 0	CONFLICTING INDEPENDENT VARIABLES CCR < 0
	Most Complementary → Least Complementary	Least Conflicting → Most Conflicting
1965-67	Na ζ (λ;W)	YF G Nb e Y
1967-70	Na ζ (λ,W)	ε YF G Nb e Y
1970-74	Na ζ (λ,W) ε YF	G Nb e Y
1974-77	Na ζ (λ,W) ε YF G	Nb e Y
1977-80	Na ζ (λ,W) ε YF G	Nb e Y

Table 5

CCRT's, THE PERCENTAGE CONTRIBUTION OF THE EXOGENOUS,
POLICY/EXOGENOUS AND POLICY VARIABLES TO INDUCED GROWTH AND THE CCRT,
AND THEIR EFFECTS ON REGIONAL INEQUALITY

	1965-67	1967-70	1970-74	1974-77	1977-80
CCRT	6.724	- 0.576	0.612	0.503	- 0.144
Percentage Contribution to Induced Growth					
	1965-67	1967-70	1970-74	1974-77	1977-80
Exogenous	1031.1%	97.5%	114.3%	106.8%	91.8%
Policy/Exogenous	-630.6	- 13.9	1.2	0.4	---
Policy	-300.5	16.4	- 15.5	- 7.2	8.2
Percentage Contribution to CCRT					
Exogenous	- 2.6%	11.5%	6.2%	38.6%	- 97.7%
Policy/Exogenous	-45.4	6.3	3.8	0.7	---
Policy	148.0	82.2	90.0	60.7	197.7
Effect on Regional Inequality					
Exogenous	Worsen	Worsen	Improve	Improve	Improve
Policy/Exogenous	Worsen	Worsen	Improve	Improve	---
Policy	Improve	Worsen	Improve	Improve	Worsen

Table 6
PERCENTAGE CHANGE OF THE EXOGENOUS AND POLICY VARIABLES
AND THEIR GROWTH RATE COEFFICIENTS

Percentage Change of Exogenous YF		1965-70	1967-70	1970-74	1974-77	1977-80
		8.50%	7.39%	14.94%	9.87%	7.95%
Policy	e	-16.48%	9.60%	-17.99%	-9.15%	9.81%
	ϵ	---	67.02	50.48	5.93	---
	G	15.00	27.77	1.54	69.92	12.11
	γ	52.33	16.65	-39.29	-11.98	---
Growth Rate Coefficients*						
Exogenous YF		625.13	623.23	503.30	372.28	334.88
Policy	e	94.62	72.62	59.85	31.59	23.50
	ϵ	---	0.82	1.03	1.00	---
	G	0.73	0.77	0.74	0.49	0.68
	γ	-0.002	-0..	-0.003	-0.001	---

*The Growth Rate Coefficients are the indicated variables' coefficients in equation 8.

SOURCES:

Calculated from data in Fundação Getulio Vargas, Conjuntura, various issues; Office of the President, Economic Report of the President, 1981; and Table 2 above.

NOTES

1. The effect of relaxing these assumptions is merely to complicate the analysis presented below. The major conclusions and implications remain the same.
2. Although a variable's growth rate is technically different than the proportional change in that variable, the two terms will be used synonymously in this paper.
3. It should be noted that inequality can worsen even though the regional income levels are increasing. This situation is analogous to the fact that the Gini coefficient for the personal income distribution can increase while the levels of personal income of all individuals are increasing.
4. The condition that $E_{i1} + E_{j2} < 1$ is a sufficient condition for the model's stability. See Appendix I for proof and interpretation of these conditions.
5. The Total or Aggregate Complementarity-Conflict ratio is derived by dividing equation 9 by equation 8 and simplifying.
6. For a review of this literature see Harber (1982a).
7. For example, see Haddad and Andrade (1974), Rebouças (1976), Baer and Geiger (1978), and Martin and Schuh (1978).
8. The model is a synthesis and extension of the models analyzed in Harber (1982a) and Harber (1982b). The parameter estimates presented below are also drawn from these works.
9. See Appendix II for the presentation of the structural equations and Harber (1982a) for a detailed discussion of Brazil's incentive programs.
10. The result that the pure policy variables had negative effects on growth in the 1965-67, 1970-74 and 1974-77 subperiods is primarily due to the effective revaluation of the real exchange rate despite the substantial nominal devaluations which occurred.

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APPENDIX I: STABILITY ANALYSIS OF THE BASIC TWO REGION MODEL

To analyze the stability of the model presented in section II, assume all the exogenous and policy variables are unchanging so that the model reduces to the following:

$$Y_a = E_a(Y_a, Y_b) + M_b(Y_b) - M_a(Y_a) = F_a(Y_a, Y_b)$$

$$Y_b = E_b(Y_b, Y_a) + M_a(Y_a) - M_b(Y_b) = F_b(Y_b, Y_a)$$

where

$$F_{a1} = E_{a1} - M_a' < 1 \quad F_{b1} = E_{b1} - M_b' < 1$$

$$F_{a2} = F_{a2} + M_b' > 0 \quad F_{b2} = E_{b2} + M_a' > 0$$

or, in equilibrium

$$Y_a - F_a(Y_a, Y_b) = 0$$

$$Y_b - F_b(Y_b, Y_a) = 0.$$

Using the standard interpretation of Keynesian product market equilibrium, treating Y_a and Y_b as production levels and F_a and F_b as total net purchases, then the disequilibrium adjustment processes are as follows:

- i) For a given level of Y_a , if Y_b is such that $Y_b > (<) F_b(Y_b, Y_a)$, then production exceeds (falls short of) purchases so that stocks are accumulating (decumulating) in Region B and production is decreased (increased); and
- ii) For a given level of Y_b , if Y_a is such that $Y_a > (<) F_a(Y_a, Y_b)$, then production exceeds (falls short of) purchases so that stocks are accumulating (decumulating) in Region A and production is decreased (increased).

The equilibrium conditions given above can be used to define the combinations of Y_a and Y_b satisfying these conditions. Totally differentiating the equilibrium conditions yields the following expressions for the slopes of these equilibrium loci:

$$\text{Region A: } \left. \frac{dY_a}{dY_b} \right|_A = \frac{F_{a2}}{1 - F_{a1}} > 0$$

$$\text{Region B: } \left. \frac{dY_a}{dY_b} \right|_B = \frac{1 - F_{b1}}{F_{b2}} > 0.$$

Figures A.1 and A.2 show the two possibilities for a non-neutral equilibrium of the model. In Figure A.1 the slope of Region B's equilibrium locus (BB) is greater than the slope of Region A's equilibrium locus (AA) and the equilibrium is stable. In Figure A.2 the relationship between the slopes of the equilibrium loci is reversed and the equilibrium is unstable. Thus, it is clear that the necessary condition for the model's stability is

$$\left. \frac{dY_a}{dY_b} \right|_B > \left. \frac{dY_a}{dY_b} \right|_A$$

or

$$\frac{1 - Fb_1}{Fb_2} > \frac{Fa_2}{1 - Fa_1}.$$

Substitution of the expressions for the partial derivatives of the F_i functions and manipulation of this expression shows that the model's stability guarantees that the denominator of the coefficients in equations 7, 8, and 9 are positive. It is also easily shown that a sufficient condition for stability is

$$Ea_1 + Eb_2 < 1 \text{ and } Eb_1 + Ea_2 < 1.$$

These conditions simply state that the change in non-trade, direct expenditures in both regions resulting from a change in either region's income is less than the initial change in income.

FIGURE A.1:
Stable Equilibrium in the
Two Region Model

FIGURE A.2:
Unstable Equilibrium in the
Two Region Model

APPENDIX II: THE UNDERLYING MODEL OF SECTION IV

The macro-model underlying the analysis of section IV is based upon the models developed in Harber (1982) and Harber (forthcoming). These works are designed to evaluate the effects of Brazil's fiscal incentive system on the Northeast region. All variables are in real terms. The structural equations for the two regions are the following:

Definitions of Disposable Income: $YDi = Yi - Ti$

Consumption Functions: $Ci = Ci(YDi)$, $0 < Ci' < 1$

Government Revenue Functions : $TGi = TGi(Yi, \epsilon)$, $TGi_2 < 0 < TGi_1 < 1$

Incentive Tax Functions: $Tii = Tii(Yi)$, $0 < Tii' < 1$

Total Tax Functions: $Ti = TGi + Tii = Ti(Yi, \epsilon)$

Investment Functions: $Ia = (1 + \lambda)\zeta Na Z$

$Ib = (1 + \lambda)(1 - \zeta)Nb Z$, $0 < \zeta < 1$

Government Expenditure Functions: $Ga = \gamma G$, $0 < \gamma < 1$

$Gb = (1 - \gamma)G$

Foreign Export Functions: $xi = xi(YF, \epsilon, \epsilon)$; $xi_1, xi_2, xi_3 > 0$

Foreign Import Functions: $pi = pi(YDi, \epsilon)$, $pi_1 > 0$, $pi_2 < /> 0$

Regional Import Functions: $Mi = Mi(YDi)$, $Mi' > 0$

Regional Export/Import Functions: $Xi = Mj$; $i, j = a, b$; $i \neq j$

Available Incentive Funds: $Z = WZ_{t-1} + Tia + Tib$

where

ϵ = the degree of export subsidy granted through the tax system;

ζ = Region A's share of the disbursed incentive funds;

γ = Region A's share of total, exogenous government expenditures (G);

λ = the ratio of private (non-incentive-induced) investment to incentive induced investment;

e = the real exchange rate (domestic currency units per unit of foreign currency;

N_i = Region i 's aggregate incentive-investment multiplier,
 $N_i > 0$;

W = the fraction of incentive funds retained per time period, $0 < W < 1$; and

IF = foreign (United States) income.

Aggregate regional expenditures are composed of the consumption, investment, government and net foreign export expenditures of each region. Thus

$$E_i = C_i + I_i + G_i + x_i - p_i$$

$$= E_i(Y_i, Y_j, N_i, YF, e, \varepsilon, G, \gamma, \lambda, \zeta, W).$$