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ECONOMIC ALTERNATIVES FOR MEXICO: A QUANTITATIVE ANALYSIS°

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1. INTRODUCTION

This work is intended as a step toward multilevel planning—identifying the information flows necessary for consistency between project, sectoral, and macroeconomic decisions. (Parallel process-analysis models of Mexico's agricultural and energy sectors have been constructed.) To build a macroeconomic model that will yield shadow prices relevant to specific project decisions, it appears essential to allow for labor inputs. Otherwise, it is implied that the marginal productivity of labor is zero. With a constant-returns technology, this, in turn, implies that the marginal productivity of capital will coincide with the economy-wide average output-capital ratio. As noted by Harberger (1967, p. 142), a zero shadow price for labor (hence a high shadow price for capital) is "virtually a kiss of death for projects with long gestation periods or long economic lives."

For a macroeconomic model to generate meaningful criteria for project decisions, it is not sufficient that "labor" have a positive shadow price. Since the skill-mix differs substantially among alternative investment projects, and since wage differentials between skill groups appear quite wide in Mexico, it is essential to separate labor by skill categories. Skill disaggregation is easier said than done.

In our initial experiments, we adopted a manpower requirements formulation —hoping to avoid the data difficulties inherent in a human-capital-formation approach. The manpower availability in each skill category was projected exogenously—as though the supply of labor skills were completely inelastic. Employing this formulation, plus an activity-analysis technology that turned out to be virtually as rigid as a Leontief system, we ran into major difficulties with respect to the shadow price of labor. The efficiency price differentials between skills were either zero—or with a minor perturbation in labor availability, these differentials became unbelievably large.[1] Under the influence of Marshall's dictum ("*natura non facit saltum*"), we have therefore searched for additional elements of substitution and

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[1] Much the same experience is reported in Bruno (1966, pp. 343–45). Apparently, in both these numerical models, there was insufficient indirect substitution via international trade to avoid knife-edge behavior of the shadow price with respect to the exogenously specified availability of labor skills.

have turned away from regarding labor skills as a demographically given primary factor of production. Much like Correa and Tinbergen (1962); Spiegelman, Baum, and Talbert (1965); Adelman (1966); and Bowles (1967); the current version of DINAMICO includes endogenous time-phased activities for upgrading unskilled into skilled manpower. Also included are activities for capital-labor substitution in agriculture and for short-run substitution between skills. Our calculations suggest that Mexico is approaching the end of the labor-surplus phase of her development, and that capital-labor substitution could become increasingly important.

With the exception of labor, the dynamic multisector linear programming model (for short, DINAMICO) follows along familiar lines. Among the standard ingredients are: a 15-sector current-account interindustry matrix, capital coefficients linking investment demands to capacity expansion in each of six future time periods, and alternative activities for trade-balance improvement.[2] In part, foreign exchange is viewed as an exogenously given primary resource—and in part, as an item for which there exist substitution possibilities. In addition to foreign-exchange earnings through traditional exports and tourism, the model allows for the possibility of exporting manufactures from high-cost "infant" industries. It is supposed that foreign exchange is also available through capital inflows—one portion on concessional terms and another portion through direct private foreign investment.

Altogether, the programming matrix contains some 300 constraint rows, 400 activity columns, and 4,000 nonzero coefficients. At this size, numerical optimization did not prove to be a bottleneck. The model evolved during a two-year period of experimentation. With a continuing series of improvements in the basic data, there were six successive versions of the "basic case." Eventually, a special-purpose program was written to generate the matrix and to facilitate data revisions.

2. Alternatives to the Basic Case

For ease in future reference, we define the "basic case" to be the one described in memoranda 71-9, 71-12, and 71-13.[3] Table 1 contains a list of the eight alternatives to be evaluated here. These eight cases refer to alternative formulations of DINAMICO's constraints on the primary factors of production: foreign exchange and labor. Also considered are alternatives to the maximand adopted for the basic case: aggregate consumption, subject to a "gradualist" constraint on the time path and a target annual growth rate $g = 7$ percent. The eight alternatives are examined one at a time—neglecting interactions between them.

The individual alternatives stem not only from different value judgements as to what is desirable, but also from different practical judgements as to what is

[2] It is assumed that the reader is already familiar with standard references on dynamic numerical planning models, e.g., Adelman (1966); Chenery and MacEwan (1966); Bruno (1967); Eckaus and Parikh (1968); Bruno, Dougherty, and Fraenkel (1970); and Murakami, Tokoyama, and Tsukui (1970).

[3] These reports are available upon request to the Development Research Center, International Bank for Reconstruction and Development. 1818 H Street, N.W., Washington, D.C. 20433. Eventually, they will appear as chapters in *Multi-Level Planning: Case Studies in Mexico.*

TABLE 1
ALTERNATIVES TO THE BASIC CASE

Assumptions Underlying the Basic Case	Alternative Assumptions	Identification Number of Alternative Case
Maximand: aggregate consumption, subject to gradualist restriction and annual growth target $g = 7\%$	Maximand: same except growth target $g = 6\%$	1
	Maximand: same except growth target $g = 8\%$	2
	Maximand: discounted consumption	3
	Maximand: terminal consumption	4
Initial differential of 30% between domestic costs and foreign-exchange earnings from high-cost manufactured exports	Initial export cost differential = 50%	5
Direct private capital inflows (FDP^t) restricted to an average of 5.0 and a maximum of 5.5 billion pesos in any one year	Same average rate, but—except for the initial and terminal years—no limit on inflows (FDP^t) in any one year	6
Includes constraints on the supply and demand for labor skills	Labor constraints eliminated	7
Allows for capital-labor substitution in agriculture through activities KA^t	Doubled marginal productivity of labor in agriculture, thereby doubling cost of activities KA^t	8

politically or technically feasible—e.g., one policymaker will say that the basic case is altogether too pessimistic in projecting the subsidy required for promoting manufactured exports; another will say that we have been too optimistic on this score. Case 5 permits us to check for the indirect implications of these alternative views. Similarly, through case 6, we may examine another aspect of the foreign-exchange constraints—the year-by-year limits on the inflows of foreign private capital.

A priori, it might be supposed that alternatives 5 and 6 would have a significant effect upon the GDP growth rate. Similarly, one might have anticipated sizable macroeconomic effects from such alternatives as: (1) and (2), changing the annual growth target to 6 or 8 percent; or (3), changing the maximand to discounted consumption; or (4), changing the maximand to terminal consumption.

Under each of these alternatives—when taken one at a time—it turns out that the 1968–1980 optimal annual GDP growth rate varies only between 6.8 and 7.1 percent. The output growth rates for individual sectors also tend to be insensitive to the variations considered under cases 1–6. The effects are concentrated upon a comparatively small number of primal variables: the amount of capital-labor substitution within agriculture, the inflows of foreign capital, and the marginal export activities for trade-balance improvement.

It is not until we turn to cases 7 and 8—those involving the labor constraints —that the alternatives become radically different. Case 7 is calculated as though the marginal productivity of labor in Mexican agriculture were zero, as though there were no social costs of rural-urban labor transfer, and as though the social product foregone by creating human capital were also zero. With the labor-surplus hypothesis carried to this extreme, all labor constraints may be neglected. The marginal productivity of physical capital would rise to 30–33 percent per year —virtually identical to the incremental ratio of aggregate output to physical capital. This also means that the 1968–1980 optimal annual GDP growth rate would be 7.6 percent, and that each sector's output requirements would be increased correspondingly.

From the viewpoint of income distribution, perhaps the most significant alternative is case 8. Here the labor constraints are reintroduced. It is supposed that long-term credit is made available to the agricultural sector on more favorable terms than heretofore, and that this policy is pushed far enough so as to double the marginal rate of substitution of capital for unskilled agricultural workers. The macroeconomic and foreign-trade effects are not sizable, but the income distribution then shifts significantly in favor of unskilled labor.

For our quantitative comparison of alternatives, the results are summarized in Tables 2 through 7. (Further details are to be found in the computer listings. These are available for inspection in the author's office.) Tables 2 through 7 are arranged as follows:

Table 2. Macroeconomic results
Table 3. Resource gap—financial flows
Table 4. Foreign-exchange projections, 1980
Table 5. Efficiency prices of foreign exchange and foreign aid
Table 6. Gross production levels, 1980
Table 7. Employment, efficiency wages, and labor income, 1980

TABLE 2
MACROECONOMIC RESULTS
[billions of 1960 pesos]

	Case Identification	CON^t 1974[1]	CON^t 1980[2]	SAV^t 1974[1]	SAV^t 1980[2]	INV^t 1974[1]	INV^t 1980[2]	GDP^t 1974[1]	GDP^t 1980[2]	mps, 1968–80 $= \frac{SAV^4 - SAV^0}{GDP^4 - GDP^0}$	Annual GDP Growth 1968–80
0	Basic case	303.6	445.8	81.9	136.8	81.9	128.2	385.5	582.6	26.3%	6.9%
1	$g = 6\%$	308.1	448.8	78.3	123.9	78.3	115.2	386.4	572.7	23.0	6.8
2	$g = 8\%$	298.9	441.9	89.0	150.2	89.0	142.6	387.8	592.1	29.6	7.1
3	Discounted consumption	298.9	442.6	90.7	152.3	91.8	144.7	389.7	594.9	30.0	7.1
4	Terminal consumption	295.8	434.4	89.4	148.8	86.5	145.4	385.2	583.2	30.0	6.9
5	50% export cost differential	303.1	444.6	81.3	136.3	81.3	127.6	384.4	580.8	26.3	6.9
6	No annual limits on FDP^t	303.7	446.0	83.2	143.2	87.6	125.5	386.8	589.2	27.7	7.0
7	Labor constraints eliminated	316.6	478.4	89.5	146.6	89.5	137.9	406.1	624.9	26.0	7.6
8	Doubled capital-labor substitution rate	300.2	437.3	86.1	132.3	86.1	123.6	386.3	569.6	26.0	6.7

[1] Period $t = 2$.
[2] Period $t = 4$.

TABLE 3
RESOURCE GAP—FINANCIAL FLOWS[1]
[billions of 1960 pesos]

Case Identification	Foreign Direct Private Capital Inflows, FDP^t '71 1	'74 2	'77 3	'80 4	'83 5	'86 6	Less: Interest and Profit Remittances on Direct Private Capital Inflows of Prior Years '71 1	'74 2	'77 3	'80 4	'83 5	'86 6
0 Basic case	5.0	5.5	5.5	5.5	3.5	5.0	−4.9	−7.5	−10.4	−13.2	−16.1	−17.9
1 $g = 6\%$	5.0	5.5	5.5	5.5	3.5	5.0	−4.9	−7.5	−10.4	−13.2	−16.1	−17.9
2 $g = 8\%$	5.0	5.5	3.5	5.5	5.5	5.0	−4.9	−7.5	−10.4	−12.2	−15.1	−17.9
Discounted consumption	3.0	5.5	5.5	5.5	5.5	5.0	−4.9	−6.5	−9.3	−12.2	−15.1	−17.9
4 Terminal consumption	0	0	0	2.4	5.5	5.0	−4.9	−4.9	−4.9	−4.9	−6.1	−9.0
5 50% export cost differential	5.0	5.5	5.5	5.5	3.5	5.0	−4.9	−7.5	−10.4	−13.2	−16.1	−17.9
6 No annual limits on FDP^t	5.0	9.9	9.3	0.8	0	5.0	−4.9	−7.5	−12.7	−17.6	−17.9	−17.9
7 Labor constraints eliminated	5.0	5.5	5.5	5.5	3.5	5.0	−4.9	−7.5	−10.4	−13.2	−16.1	−17.9
8 Doubled capital-labor substitution rate	5.0	5.5	1.3	3.2	5.5	5.0	−4.9	−7.5	−10.4	−11.0	−12.7	−15.6

Case Identification	Plus: Concessional Capital Inflows Less Interest, $\overline{FC}^t - \overline{INFC}^t$ '71 1	'74 2	'77 3	'80 4	'83 5	'86 6	= Resource Gap, $RGAP^t$ '71 1	'74 2	'77 3	'80 4	'83 5	'86 6
0 Basic case	2.4	2.0	.9	−.9	−2.9	−4.7	2.5	0	−4.0	−8.6	−15.5	−17.6
1 $g = 6\%$	2.4	2.0	.9	−.9	−2.9	−4.7	2.5	0	−4.0	−8.6	−15.5	−17.6
2 $g = 8\%$	2.4	2.0	.9	−.9	−2.9	−4.7	2.5	0	−6.0	−7.6	−12.5	−17.6
3 Discounted consumption	2.4	2.0	.9	−.9	−2.9	−4.7	0.5	1.0	−2.9	−7.6	−12.5	−17.6
4 Terminal consumption	2.4	2.0	.9	−.9	−2.9	−4.7	−2.5	−2.9	−4.0	−3.4	−3.5	−8.7
5 50% export cost differential	2.4	2.0	.9	−.9	−2.9	−4.7	2.5	0	−4.0	−8.6	−15.5	−17.6
6 No annual limits on FDP^t	2.4	2.0	.9	−.9	−2.9	−4.7	2.5	4.4	−2.5	−17.7	−20.8	−17.6
7 Labor constraints eliminated	2.4	2.0	.9	−.9	−2.9	−4.7	2.5	0	−4.0	−8.6	−15.5	−17.6
8 Doubled capital-labor substitution rate	2.4	2.0	.9	−.9	−2.9	−4.7	2.5	0	−8.2	−8.7	−10.1	−15.3

[1] By year and period.
Period $t = 1$: 1971. $t = 3$: 1977. $t = 5$: 1983.
$t = 2$: 1974. $t = 4$: 1980. $t = 6$: 1986.

TABLE 4
FOREIGN EXCHANGE PROJECTIONS, 1980
[billions of 1960 pesos]

Case Identification	Imports	Merchandise Exports, at Producers' Prices, Z_i^4									
		$i^1 =$ 1	2	3	4	5	6	7	8	9	10
0 Basic case	41.13	4.90	3.78	.54	5.80	.98	.62	2.07	.29	.72	2.18
1 $g = 6\%$	38.95	4.90	3.78	.54	5.80	.98	.62	2.07	.29	.72	2.18
2 $g = 8\%$	43.27	4.90	3.78	.54	5.80	.98	.62	2.07	.29	.72	1.80
3 Discounted consumption	43.87	4.90	3.78	.54	5.80	.98	.62	2.07	.29	.72	2.18
4 Terminal consumption	43.11	4.90	3.78	.54	5.80	.98	.62	2.07	.29	.72	2.18
5 50% export cost differential	40.37	7.77	3.78	.54	5.80	.98	.62	2.07	.29	.72	2.18
6 No annual limits on FDP^t	41.15	4.90	3.78	.54	5.80	.98	.62	2.07	.29	.72	2.18
7 Labor constraints eliminated	43.25	7.77	3.78	.54	5.80	.98	.62	2.07	.29	.23	2.18
8 Doubled capital-labor substitution rate	39.71	4.90	3.78	.54	5.80	.98	.62	2.07	.29	.72	2.18
Exogenously specified upper bound, $Z_i^0(1 + e_i)^{12}$		7.77	3.78	.54	5.80	.98	.62	2.07	.29	.72	2.18
Exogenously specified lower bound, $Z_i^0(1 + \varepsilon_i)^{12}$		4.90	2.36	.45	2.88	.58	.31	0.66	.12	.23	0.56

[1] i = item.

TABLE 4 (*concluded*)

Case Identification	Exports of High-Cost Manufactures, at Producers' Prices, $\sum_{\tau=1}^{4} ZM^{\tau}$	Foreign Exchange Earnings, at Market Prices		Resource Gap, $RGAP^4$ = Imports $- ZA^4 - ZT^4$
		Merchandise Exports,[2] ZA^4	Tourism, ZT^4	
0 Basic case	12.01	39.14	10.63	−8.64
1 $g = 6\%$	10.13	36.96	10.63	−8.64
2 $g = 8\%$	13.34	40.23	10.63	−7.59
3 Discounted consumption	13.48	40.83	10.63	−7.59
4 Terminal consumption	9.21	35.90	10.63	−3.42
5 50% export cost differential	8.26	38.12	10.89	−8.64
6 No annual limits on FDP^t	19.84	48.19	10.63	−17.67
7 Labor constraints eliminated	4.84	33.60	18.29	−8.64
8 Doubled capital-labor substitution rate	10.84	37.78	10.63	−8.70
Exogenously specified upper bound, $Z_i^0(1 + e_i)^{12}$	–	–	18.29	
Exogenously specified lower bound, $Z_i^0(1 + \varepsilon_i)^{12}$	0	–	10.63	

[2] ZA^4 = merchandise exports, at market prices.
$.8658\, ZA^4$ = merchandise exports, at producers' prices = $\sum_{i=1}^{10} Z_i^4 + \sum_{\tau=1}^{4} ZM^{\tau}$.
$.1125\, ZA^4$ = commerce margins on merchandise exports.
$.0217\, ZA^4$ = service margins on merchandise exports.

TABLE 5
EFFICIENCY PRICES OF FOREIGN EXCHANGE AND FOREIGN AID

Case Identification	1960 Pesos Worth of Maximand[1] per Thousand 1960 Pesos Worth of Item				Efficiency Price of Foreign Exchange Relative to Price of Tradable Manufactures		"Own" Rate of Interest on Foreign Exchange, 1974–80, Annual Rate
	Foreign Exchange (rows [F^t])		Foreign Aid (rows [$FGAP^t$])				
	1974[2]	1980[3]	1974[2]	1980[3]	1974[2]	1980[3]	
0 Basic case	72.40	24.72	72.40	24.72	1.15	1.15	20%
1 $g = 6\%$	77.07	26.17	77.07	26.17	1.15	1.15	20
2 $g = 8\%$	74.41	20.55	61.85	25.98	1.16	1.13	24
3 Discounted consumption	547.92	238.20	759.36	333.96	1.13	1.13	15
4 Terminal consumption	373.61	290.17	1.284.79	892.21	1.02	1.20	4
5 50% export cost differential	82.08	29.92	78.49	29.92	1.28	1.35	18
6 No annual limits on FDP^t	71.31	27.22	62.97	27.22	1.05	1.21	17
7 Labor constraints eliminated	130.91	24.61	130.91	24.61	1.17	1.17	32
8 Doubled capital-labor substitution rate	53.59	22.96	53.59	22.96	1.13	1.17	15

[1] Except for cases 3 and 4, the maximand is CON^1, and the units of measurement of efficiency prices are therefore identical. In case 3, the unit of measurement refers to discounted consumption; in case 4, to terminal consumption.
[2] Period $t = 2$.
[3] Period $t = 4$.

TABLE 6
GROSS PRODUCTION LEVELS, 1980, BY SECTOR
[billions of 1960 pesos]

Case Identification	Agriculture (1)	Mining (2)	Petroleum (3)	Food (4)	Textiles (5)	Wood (6)	Chemicals (7)	Nonmetallic (8)
0 Basic case	74.6	8.6	39.0	112.8	54.8	22.6	54.8	14.9
1 $g = 6\%$	73.3	8.4	38.3	112.0	54.6	21.9	53.7	14.0*
2 $g = 8\%$	76.3	8.8	39.5	112.9	54.7	23.1	55.6	16.0*
3 Discounted consumption	76.2	8.9	39.7	113.3	54.8	23.3	55.9	16.1*
4 Terminal consumption	74.4	8.8	38.9	108.5	53.4	22.6	53.6	15.9*
5 50% export cost differential	77.4	8.5	38.8	110.9	54.4	22.3	53.8	14.9
6 No annual limits on FDP^t	76.5	8.7	39.5	118.1	55.8	23.3	57.4	15.2
7 Labor constraints eliminated	80.0*	8.8	41.3*	115.7	58.7*	23.6	56.1	15.9*
8 Doubled capital-labor substitution rate	74.0	8.4	38.0	110.1	53.6	21.9	53.2	14.4

Case Identification	Basic Metals (9)	Machinery (10)	Construction (11)	Electricity (12)	Commerce (13)	Transportation (14)	Services (15)
0 Basic case	37.0	100.1	59.1	19.8	196.7	24.2	161.0
1 $g = 6\%$	34.9	95.2	53.9*	19.4	193.9	24.1	159.1
2 $g = 8\%$	39.1*	104.4	64.9*	20.2	199.1	24.2	162.1
3 Discounted consumption	39.6*	106.1*	65.4*	20.3	200.2	24.3	163.5
4 Terminal consumption	38.6	103.8	65.9*	19.9	196.3	23.8	161.3
5 50% export cost differential	36.3	98.4	59.9	19.7	195.5	24.1	160.4
6 No annual limits on FDP^t	38.1	101.8	58.5	20.0	198.2	24.3	161.5
7 Labor constraints eliminated	37.9	105.5*	65.4*	21.1*	210.2*	26.2*	170.3*
8 Doubled capital-labor substitution rate	35.7	96.7	56.8	19.3	192.0	23.6	156.6

NOTE: * Differs by more than 5% from level shown for basic case.

TABLE 7
EMPLOYMENT, EFFICIENCY WAGES, AND LABOR INCOME, 1980, BY LABOR SKILL CATEGORY[1]

Case Identification	Employment. ROL_s^4 (millions of persons)							Efficiency Wages. Annual Average Centered on 1980[2] (thousands of 1960 pesos per man-year of skill s)				
	Skill Category					Subtotal, 1–4	Total, 1–5	Skill Category				
	1	2	3	4	5			1	2	3	4	5
0 Basic case	.183	1.310	2.673	9.521	6.765	13.687	20.452	112.1	53.4	23.0	7.5	3.9
1 $g = 6\%$	.176	1.286	2.619	9.265	7.350	13.346	20.696	106.8	53.7	23.4	7.5	3.9
2 $g = 8\%$	.189	1.328	2.720	9.759	6.359	13.996	20.355	129.4	59.9	24.1	7.9	4.2
3 Discounted consumption	.191	1.339	2.741	9.836	5.996	14.107	20.103	75.9	41.8	17.7	8.2	4.8
4 Terminal consumption	.187	1.319	2.693	9.667	5.734	13.886	19.600	41.8	21.1	12.7	8.7	5.5
5 50% export cost differential	.182	1.305	2.661	9.467	6.884	13.615	20.499	111.6	52.0	22.9	7.6	4.0
6 No annual limits on FDP^t	.186	1.318	2.698	9.623	6.901	13.825	20.726	117.9	53.8	24.2	7.9	4.2
7 Labor constraints eliminated	.193	1.387	2.839	10.134	9.895	14.553	24.448	–	–	–	–	–
8 Doubled capital-labor substitution rate	.178	1.274	2.602	9.254	7.239	13.308	20.547	90.2	52.8	24.2	11.3	7.9

[1] Skill category $s = 1$: engineers and scientists.
$s = 2$: other professional and technical workers.
$s = 3$: administrative and clerical workers.
$s = 4$: manual and sales workers outside agriculture.
$s = 5$: unskilled agricultural workers.

[2] Average of efficiency wages for 1977, 1980, and 1983, normalized by dual variable for consumption goods.

TABLE 7 (*concluded*)

Case Identification	Labor Income = Employment × Efficiency Wages (billions of 1960 pesos)						Aggregate Consumption (billions of 1960 pesos) CON^4	Labor Income as Fraction of Aggregate Consumption
	Skill Category					Total, 1–5		
	1	2	3	4	5			
0 Basic case	20.5	70.0	61.5	71.4	26.4	249.8	445.8	56%
1 $g = 6\%$	18.8	69.1	61.3	69.5	28.7	247.4	448.8	55
2 $g = 8\%$	24.5	79.5	65.6	77.1	26.7	273.4	441.9	62
3 Discounted consumption	14.5	56.0	48.5	80.7	28.8	228.5	442.6	52
4 Terminal consumption	7.8	27.8	34.2	84.1	31.5	185.4	434.4	43
5 50% export cost differential	20.3	67.0	60.9	71.9	27.5	248.5	444.6	56
6 No annual limits on FDP^t	21.9	70.9	65.3	76.0	29.0	263.1	446.0	59
7 Labor constraints eliminated	–	–	–	–	–	–	478.4	–
8 Doubled capital-labor substitution rate	16.1	67.3	63.0	104.6	57.2	308.2	437.3	70

3. Alternative Objective Functions

Cases 1 through 4 all deal with the problem of welfare distribution between successive generations—near future versus distant future increases in aggregate consumption. Somewhat surprisingly, these different objective functions do not lead to great differences in the absolute levels of consumption during the early time periods. (See Figure 1 and Table 8.)

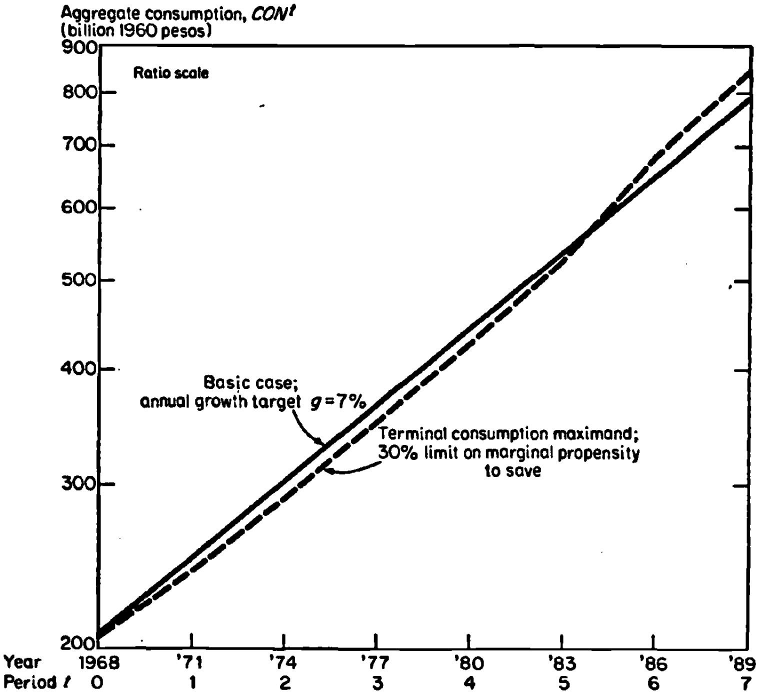

FIGURE 1 Alternative Time Paths of Aggregate Consumption

TABLE 8
Aggregate Consumption, CON^t: Effect of Alternative Objectives[1]
[billions of 1960 pesos]

Case Identification	1968 0	1971 1	1974 2	1977 3	1980 4	1983 5	1986 6	1989 7
0 Basic case	208.8	251.4	303.6	367.5	445.8	541.8	659.3	803.3
1 $g = 6\%$	208.8	254.1	308.1	372.3	448.8	540.0	648.6	777.9
2 $g = 8\%$	208.8	248.7	298.9	362.2	441.9	542.2	668.7	828.0
3 Discounted consumption	208.8	245.3	298.9	363.5	442.6	542.5	692.7	848.6
4 Terminal consumption	208.8	245.9	295.8	359.5	434.4	535.9	700.1	857.6

[1] By year and period.
Period $t = 0$:1968. $t = 1$:1971. $t = 2$:1974. $t = 3$:1977. $t = 4$:1980. $t = 5$:1983. $t = 6$:1986. $t = 7$:1989.

For *cases 1 and 2*, the tradeoffs are examined through variations in the asymptotic target growth rate—still retaining the restriction that the time path be of the gradualist form with *increments* of consumption growing geometrically at the annual rate of g.[4] In case 1, for example, the target rate is reduced from 7 to 6 percent. This policy would make it possible to increase CON^1 from 251.4 to 254.1 billion pesos. Higher consumption levels would also be achieved during periods $t = 2$, 3, and 4, but lower levels during all subsequent time periods. Symmetrical effects are obtained when the target growth rate is raised to 8 percent. That is, case 2 provides lower consumption levels than the basic case during periods 1 through 4, but higher levels thereafter.

Although these alternatives differ from each other by less than 1 percent in the absolute levels of near-term consumption, they do have different implications for near-term fiscal policy. By lowering the annual growth target from 7 to 6 percent, the 1968–1980 marginal savings propensity is reduced from 26.3 to 23.0 percent. (Table 2.) This means lower taxes and lower prices on the products of public-sector enterprises. Over the long term, of course, this "soft" option leads to a lower aggregate growth rate and lower employment opportunities. Conversely, if the growth target is raised to 8 percent, the required 1968–1980 marginal savings propensity is 29.6 percent. The fiscal policy tasks would become correspondingly more onerous, but the 1980 employment opportunities would then increase from 13.7 to 14.0 million jobs within the four highest-paying skill categories. (See Table 7.)

In all cases, we have supposed that there are political constraints upon Mexico's fiscal policies, and that it would be infeasible to push the marginal savings propensity above 30 percent.[5] With the gradualist objective function (cases 0, 1, and 2), typically it turns out that the 30 percent savings limit is a redundant constraint.[6] When the gradualist objective function is replaced by that of maximizing discounted consumption (*case 3*) or terminal consumption (*case 4*), the savings constraints become critically important. Without them, the time path of aggregate consumption is exceedingly erratic from one period to the next. *With* a 30 percent upper bound upon the marginal propensity to save, then—even under a growth-maximizing criterion such as terminal consumption—there are no sharp discontinuities in the optimal consumption level between two successive periods. When the savings constraint is operative, the specific form of the objective function has little effect upon the optimal values of the primal variables.[7]

For numerical evaluation in case 3, we have taken 15 percent as the annual discount rate on future consumption,[8] and have retained 7 percent as the annual

[4] For the properties of the gradualist consumption maximand—and its relation to postterminal growth—see Hopkins (1969) and Manne (1970).

[5] For the statistical base period 1960–1968, the marginal savings propensity was 23.2 percent.

[6] In case 2, the 30 percent limit on the domestic savings propensity is binding only during periods 2, 3, and 4. Even during these periods, the shadow prices are quite low for the savings constraints, rows ($GSAV^t$).

[7] The optimal dual solution *is* sensitive to differences in the objective functions. For example, it turns out that the 1974–1980 "own" rate of interest on foreign exchange is 15 percent per year in case 3, and 4 percent in case 4. (See Table 5.)

[8] In principle, the consumption discount rate is a subjectively determined parameter—one that expresses the social rate of time preference. It is sheer coincidence that the same numerical value has been employed as for the cost of foreign private capital.

target for postterminal growth. Case 4 has the identical constraints as case 3, but a different objective function. Like a "turnpike" growth model, the maximand is CON^7, the level of aggregate consumption reached during the terminal year. Despite the difference in appearance, it can be shown that there is a close relationship between the objective functions considered in cases 3 and 4. The latter may be viewed as a special case of the former—a limiting case obtained by lowering the discount rate sufficiently. With this interpretation, the objective functions of cases 3 and 4 have the identical structure—that of discounted consumption. The only difference is that the consumption discount rate is 15 percent in case 3, and that it approaches 7 percent in case 4. The numerical results (Table 8) imply that the optimal solution is insensitive to variations in the discount rate within a rather wide range—7 to 15 percent per year. With this form of model, apparently the upper bound on the marginal savings rate has far more influence upon the optimal consumption path than does the subjectively determined time discount rate.

4. Foreign Exchange

In the basic case, it turns out that the efficiency price of foreign exchange is 1.15—taking the domestic producers' price of tradable manufactures as the numéraire. Before advocating that 15 percent is therefore an appropriate tariff rate or export subsidy or adjustment in foreign-exchange parity, it is essential to check through the reasoning that led to this numerical result. In DINAMICO, one of the least reliable econometric components is the marginal cost of export earnings. The basic case was set up as though there were no limits upon the export of "infant" high-cost manufactures. It is supposed that the domestic cost of these products will exceed the foreign exchange earnings by 30 percent at the time that the manufactured item is first exported, and that this cost differential will drop to zero through the experience acquired during an 18-year period.[9] As an alternative, *case 5* is calculated as though these marginal export items will have an initial cost disadvantage of 50 percent rather than 30 percent. We continue to suppose that it will require 18 years of experience before the cost differential can be eliminated.

Case 5 makes little or no difference in the macroeconomic results (Table 2), the pattern of foreign capital inflows (Table 3), the aggregate requirements for imports (Table 4), the gross production levels (Table 6), or the employment levels (Table 7). From the viewpoint of overall reliability of DINAMICO, it is fortunate that the principal effects of this parameter change are concentrated upon a small number of variables: the commodity composition of exports (Table 4) and the shadow price of foreign exchange (Table 5). It becomes optimal to reduce the 1980 exports of high-cost manufactures from 12.01 to 8.26 billion pesos, and to offset this loss of foreign exchange through an increase in agricultural exports. Associated with this shift in the direction of comparative advantage, there is a shift in the

[9] Presumably, in order to provide a financial incentive for the export of high-cost manufactures from individual enterprises, it would be necessary to provide export subsidies. Such subsidies might take a number of forms—either outright or in the form of permission to import raw materials and equipment duty free. (Mexico is not a member country of GATT [General Agreement on Tariffs and Trade].) With any of these measures, there are administrative difficulties—but no more so than in the case of existing import restrictions. The principal difference between an import tariff and an export subsidy is that one provides an inflow of pesos to the treasury, and the other generates an outflow.

shadow price of foreign exchange. It no longer remains 1.15, but increases to 1.35 in 1980—still taking the price of tradable manufactures as the numéraire. Case 5 also means that foreign aid would have a higher marginal productivity than in the basic case.[10]

Case 6 provides an instance of interdependence between the optimal time path of capital inflows, the shadow price of foreign exchange, and the composition of exports. Here we have eliminated the year-by-year limits on the private capital inflows FDP^t ($t = 2 \ldots 5$), but have retained the overall constraint that the average inflows are not to increase above the 1971 rate. Case 6 has little effect upon the macroeconomic results or the gross production or the employment levels. The effects are concentrated upon the sources and uses of foreign exchange. It now becomes optimal to allow exports to lag and to incur a sizable foreign-exchange deficit during periods 2 and 3, then to push up the level of high-cost manufactured exports to 19.84 billion pesos in period 4 (1980), and to run a sizable foreign-exchange surplus (17.67 billion pesos) in that year. Associated with this shift in the time pattern of exports, the shadow price of foreign exchange would rise over time—from 1.05 to 1.21 between periods 2 and 4 (1974 and 1980, respectively). This also means that the marginal productivity of foreign aid would be lower during period 2 and higher during period 4 than in the basic case. (See Table 5.)

From case 6, we cannot conclude that year-by-year constraints on foreign capital inflows are essential in a model of this type. Other devices may also be employed to avoid sharp discontinuities in the time pattern of exports. Among such devices are: an upward-sloping supply curve of foreign capital, a downward-sloping demand curve for exports, or a recursive programming constraint on the rate of growth of exports.[11] Among these alternative devices, the simplest to estimate is the year-by-year limit on private capital inflows. For the basic case, this has the disadvantage that the upper bound is an effective constraint during the early time periods, and that the unknowns FDP^t appear to be predetermined. It does not happen, however, that the upper bound is always an effective constraint during the initial time periods. For examples, see cases 2, 4, and 8 in Table 3.

5. Employment and Income Distribution

For *case 7*, the labor constraints have been eliminated. This makes it possible to achieve a significantly higher aggregate growth rate, higher output rates in

[10] Except for cases 3 and 4, the 30 percent limit upon the marginal savings propensity is not a critical constraint. Except for these cases, therefore, it makes little or no difference whether the impact of additional foreign aid is measured through the shadow price of the foreign exchange rows (F^t) or through the resource gap rows ($FGAP^t$). Cases 3 and 4 are typical of the "two-gap" phenomenon. There, foreign aid has considerably more leverage than foreign-exchange earnings alone. For further discussion of the two-gap model, see the interchange between Chenery and Strout (1968) and Fei and Ranis (1968).

The shadow price of the domestic savings rows ($GSAV^t$) may be read off from Table 5 here. In all cases, this equals the difference between the shadow price of rows (F^t) and ($FGAP^t$). To prove this proposition, refer back to the coefficients of the resource gap activity $RGAP^t$ and of the concessional foreign aid activity $\overline{FC}^t$ in Table 4, memorandum 71-13.

[11] Let Z_i^t denote the exports of item i during period t, and let e_i denote the maximum feasible rate of growth of this item between periods $t - 1$ and t. Then a recursive programming constraint on exports would be written: $Z_i^t \leq (1 + e_i)Z_i^{t-1}$. See Day (1963); and Bruno, Dougherty, and Fraenkel (1970).

Note that a recursive programming constraint refers to *pairs* of unknowns, but that the export bounds in DINAMICO are imposed upon individual unknowns.

individual sectors, and greater employment opportunities outside traditional agriculture. (See Tables 2, 6, and 7.) It has already been noted that a zero shadow price for labor implies a high shadow price for capital. Almost equally dramatic are the implications for comparative advantage in foreign trade. With a zero shadow price for labor, it becomes optimal to set agricultural exports and tourism earnings at their upper rather than their lower bounds, and to place less dependence upon high-cost manufactured exports. (See Table 5.)[12] Case 7 is included here for the sake of completeness—not because we believe that it provides a realistic basis for projections.

Increasingly, Mexican policymakers are directing research toward the sources of inequities in income distribution. There is strong evidence that, along with the increase in average incomes, the extent of inequality worsened between 1950 and 1963. (During those years, the Gini coefficient of inequality increased from 0.50 to 0.55.) In part, this problem arises from interregional differences in development—and from imperfect labor mobility between regions. In 1965, for example, the 8 highest-income regions accounted for 30.3 percent of the total population, and produced 11,075 pesos per capita. The 17 lowest-income regions, with 43.8 percent of the population, produced only 2,417 pesos per capita. (Source: Navarrete [1970, p. 41 and Table 8].)

Not only regional but also occupational differences are a significant source of inequalities. During each of the years between 1950 and 1967, in industry and services the per capita output exceeded that in agriculture by a factor of approximately 5:1. Even within agriculture—despite the post-Revolution policies of agrarian reform and land redistribution—the pattern of development has been "dualistic." In the irrigated districts of the north, farming is commercialized and produces high economic returns. Elsewhere—in the central plateau and in the south—subsistence agriculture is hard pressed to keep up with the demographic pressures. (See Solis [1970, pp. 148 and 291].)

DINAMICO is too highly aggregated to be helpful in analyzing the detailed regional aspects of income inequalities and labor mobility. *Case 8* is focused on only one dimension of the tradeoff between aggregate growth versus equity in income distribution. As proxy measures for these concepts, we have taken aggregate consumption and labor's income share, both as of 1980 ($t = 4$). By measuring labor's income at efficiency wages, we have, in effect, adopted the view that money transfer payments could not be large enough to achieve a significant redistribution of real income between social classes. (If money transfers could be made sufficiently large—and transfers entailed no loss in productive efficiency—the question of a growth-equity tradeoff would not arise.)

Case 8 has been constructed as follows: Suppose that public infrastructure investments are made available for the benefit of the smallholders in the densely populated central and southern centers of Mexican agriculture. These investments might take the form of extension services, roads, tractors, irrigation, and land

[12] Rather than suppose that the marginal productivity of labor is zero in all skill classes (case 7), it might have been worth exploring a less extreme version of the labor-surplus hypothesis. Suppose, for example, that the only change in the basic case had been to assume that unskilled agricultural labor has a zero or a low marginal product. It would then be optimal to shift the composition of foreign-exchange earnings—setting agricultural exports at their upper bounds and reducing the exports of high-cost manufactures.

leveling. To the extent that the aggregate demand for agricultural products is inelastic, these investments might have to be made at the expense of northern agriculture. It is possible that this would lead to a loss in economic efficiency, but that nonetheless—from the viewpoint of income distribution—this would prove to be a desirable shift in investment policy.

For case 8, it is supposed that this reorientation of agricultural policy is pushed far enough so as to double the marginal rate of substitution of capital for unskilled agricultural workers.[13] It turns out that this would have a significant

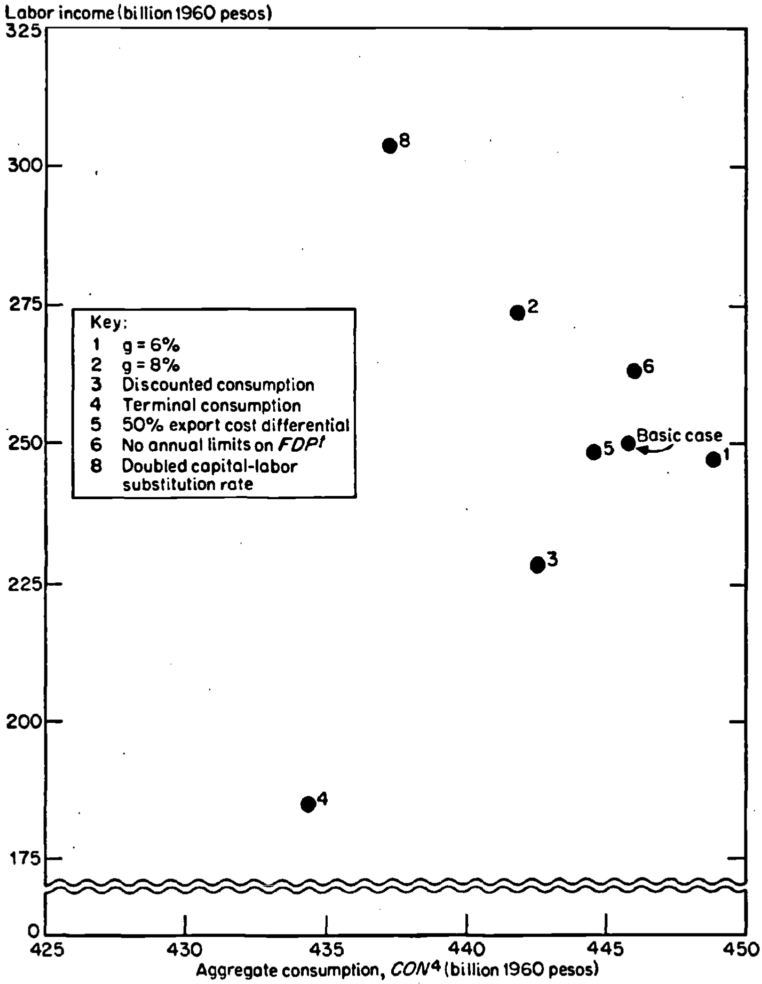

FIGURE 2 Income Distribution Versus Aggregate Growth, 1980

[13] For the basic case, at a point of time y years after 1960, it is assumed that it would require $15(1.02)^y$ thousand pesos of capital to replace one unskilled agricultural worker. For case 8, this marginal rate of substitution is instead taken to be $30(1.02)^y$.

effect not only upon the efficiency wage of agricultural workers, but also upon that of unskilled urban workers. (See Table 7 and Figure 2.) Other policy measures would also affect labor's share, e.g., case 2, where the target annual growth rate is raised to 8 percent. None of the alternatives, however, would exert as pronounced an effect upon income distribution as would this shift in the direction of agricultural investments. In 1980, this would make it possible to double the income of unskilled agricultural workers—from 26.4 to 57.2 billion pesos at 1960 prices. Total labor income would increase from 249.8 to 308.2 billion. The loss in aggregate consumption (from 445.8 to 437.3 billion pesos) might well be worth the gain in equity from such a policy.

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