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Quantitative Development Policy Analysis

Exercise solutions

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Exercise 1

Production Function: Technological Change and Factor Substitutability

1. What can you say about the evolution of the marginal productivity of labor as labor use increases? How does technological change affect the marginal productivity of labor?

The marginal productivity of labor decreases as labor use increases. Technological change increases the marginal productivity of labor at a given level of labor input.

For a given price and wage, $p = 0.057$ and $w = 1$, for example, what are the optimal labor demand l_1 and output supply q_1 corresponding to $\theta_0 = 1$, and l_2 and q_2 corresponding to $\theta_0 = 1.1$? By how much does output increase when the 10% technological change takes place?

See Table 1M.1. For a price of 0.057 and a wage of 1, the optimal labor demand is 2.98 and the resulting output is 74.7. With a technological change of 10%, labor is more productive; hence, the optimal level of labor increases by 28.2% to 3.82. Output increases by 30.7% to 97.6. This output increase has two components; the first is the direct effect of technological change at constant employment. This can be found by using the value $l = 2.98$ in cell A20 and reading the corresponding output of 82.1 in cell I20. Hence, had the labor demand not adapted, production would have increased by 10% from 74.6 to 82.1. With labor demand increase, production rose by an additional 19% to 97.6. In this example, the adjustment of labor contributes more to the increase of production than does direct technological change.

2. How does the production level change with σ? How does labor productivity change? Derive from this the significance of substitutability among factors of production.

See Table 1M.2. The value $l = 3$ is such that all three *production* functions give the same output of 75. When labor increases to 6, however, production increases to 115.4 if $\sigma = 0.5$, to 120.3 if $\sigma = 0.8$, and to 122.9 if $\sigma = 1.2$. Marginal productivity of labor is 10.9, 13.3, and 14.8, respectively, in these three cases. This shows that when the substitutability of the factors is higher, it allows the increase of production by increasing one factor (here labor), even if the other factor (capital) remains constant. By contrast, if those factors were perfectly complementary (i.e., that production requires a given proportion of the two factors), production could not increase at all if only one factor of production increased. As substitutability between capital and labor increases from 0.5 to 1.2, marginal productivity of 6 units of labor also increases. This is another way of seeing the flexibility in using labor for capital.

By how much do output and labor demand increase when p increases? Symmetrically, when the price decreases, how do output and labor demand change with different values of σ? What can you conclude about the relationship between substitutability among factors and supply elasticity? Explain.

The *supply* function gives the optimal output for given prices of input and output (see Figure 1M.1). For the output price of 0.057, supply is equal to approximately 74.5 for all three production functions. When the price increases to 0.062, supply increases to 82.0 if $\sigma = 0.5$, to 87.0 if $\sigma = 0.8$, and to 94.9 if $\sigma = 1.2$. This indicates that a higher substitutability between the factors of production corresponds to a higher supply elasticity. Why this correspondence? When the price of output increases, the value of marginal productivity of labor increases above its cost. Hence, more labor is profitably employed. We have just seen that, with a higher substitutability between capital and labor, the marginal productivity of labor does not fall as rapidly when labor increases. Hence, the optimal level of labor that can be profitably employed will be higher with a higher σ, and output will be higher. Symmetrically, when the output price declines, decreasing labor is easier when σ is larger. Hence, output declines more with higher σ in response to a decline in output price. Combining these two sides shows that a higher substitutability between capital and labor gives a higher supply elasticity, which allows the producer to adapt its labor and output level to changing prices.

Compare the declines in profit when output price declines.

Not surprisingly, better opportunities for profit correspond to this flexibility. When the output price increases from 0.057 to 0.062, the return to capital also increases as σ increases. When the output price declines, profit decreases less with a higher σ. The flexibility in production allows the producer to protect its return to the fixed factor.

3. How does the labor share in the value of production change when the wage rate increases from 1.0 to 1.2 or decreases from 1 to 0.75? Contrast the cases when σ is smaller and greater than 1. Explain this by looking at the changes in labor use in response to the wage movement.

When wages increase from 1.0 to 1.2, the labor share increases from 70.1% to 76.8% for $\sigma = 0.8$, but decreases for $\sigma = 1.2$ (Table 1M.3). When the production process is flexible ($\sigma > 1$), producers adjust to wage increases by substituting other factors of production for labor to the point that labor declines by more than wage increases (for $\sigma = 1.2$, labor declines by 50% from 2.97 to 1.48, while wages increase by 20%). When production is more rigid, factors have to remain more in proportion to each other, and the wage bill increases in total value of production.

Figure 1M.1. Supply functions

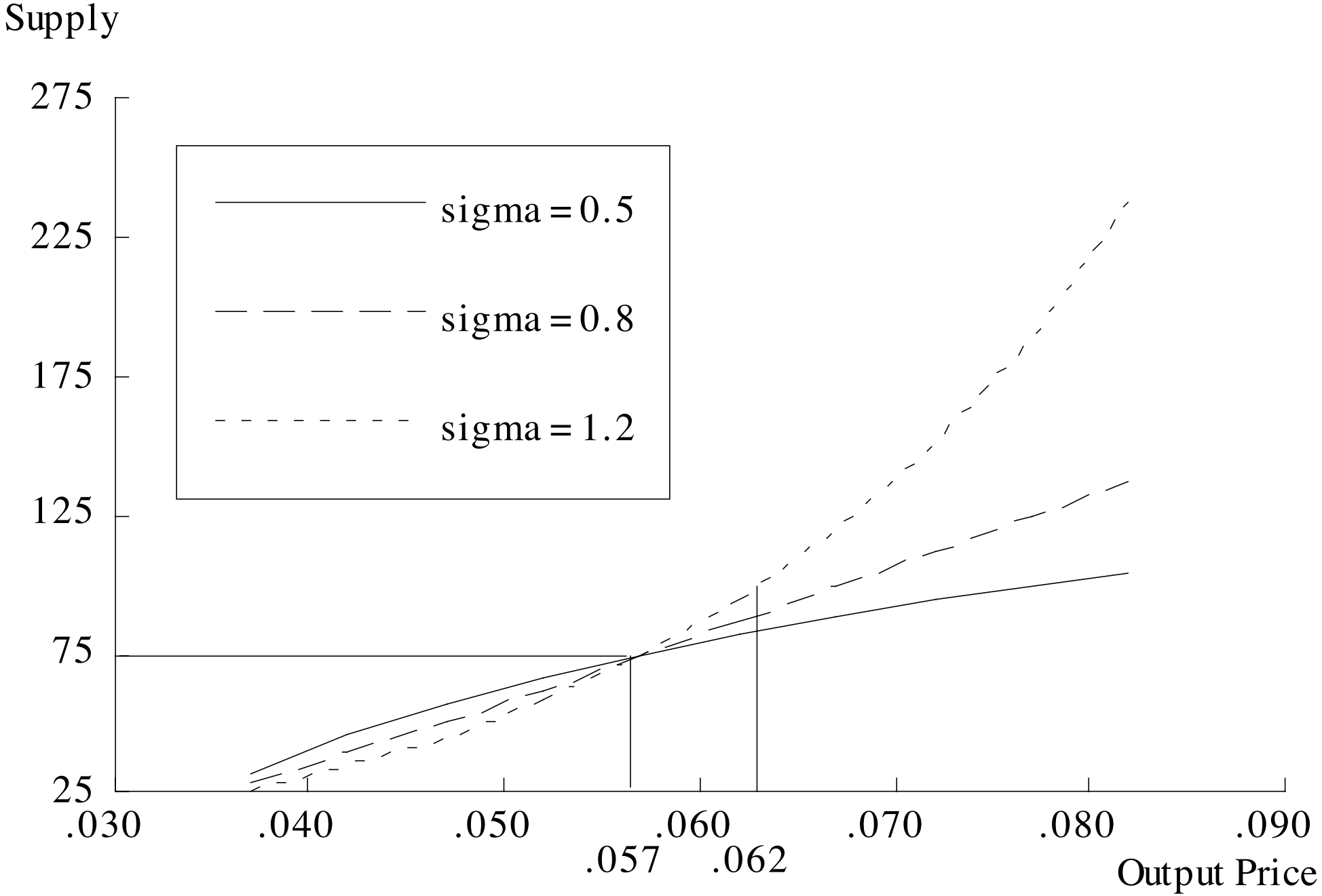


Table 1M.1. Production function: Technological change and factor substitutability (Part 1)

Parameters	Simulation 1 theta0 = 1	Simulation 2 theta0 = 1.1
sigma	.80	.80
a	25.00	25.00
alpha	.30	.30
k	3.00	3.00
theta 0	1.00	1.10
theta k	1.00	1.00
theta L	1.00	1.00
-rho	-.25	-.25

Variation of production with labor input

Labor L	Production	Marginal productivity of L	Production	Marginal productivity of L
2.00	56.2	20.3	61.9	22.3
3.00	75.0	17.5	82.5	19.3
4.00	91.5	15.7	100.7	17.2
5.00	106.5	14.3	117.1	15.8
6.00	120.3	13.3	132.3	14.6
7.00	133.1	12.4	146.4	13.7
8.00	145.2	11.7	159.7	12.9
9.00	156.6	11.1	172.3	12.2
10.00	167.5	10.6	184.2	11.7

Optimal behavior

Factor demand and supply function

Price	Wage	p/w	Labor demand	Output supply	Supply elasticity	Labor demand	Output supply	Supply elasticity
.037	1.00	.037	.82	28.9		1.12	40.3	
.042	1.00	.042	1.23	39.5	2.7	1.65	53.8	2.5
.047	1.00	.047	1.74	50.8	2.4	2.28	68.0	2.2
.052	1.00	.052	2.32	62.5	2.2	3.01	82.7	2.0
.057	1.00	.057	2.98	74.7	2.0	3.82	97.6	1.9
.062	1.00	.062	3.71	87.0	1.9	4.72	112.7	1.8
.067	1.00	.067	4.52	99.5	1.8	5.70	127.9	1.7
.072	1.00	.072	5.39	112.0	1.7	6.75	143.0	1.6
.077	1.00	.077	6.32	124.5	1.6	7.88	158.1	1.5
.082	1.00	.082	7.32	137.0	1.5	9.07	173.1	1.5

Technology

Capital/L	Output/L	Capital/L	Output/L
3.7	35.4	2.7	36.1
2.4	32.0	1.8	32.6
1.7	29.2	1.3	29.8
1.3	27.0	1.0	27.5
1.0	25.1	.8	25.5
.8	23.4	.6	23.9
.7	22.0	.5	22.4
.6	20.8	.4	21.2
.5	19.7	.4	20.1
.4	18.7	.3	19.1

Return to fixed factor and income distribution

Rent to k	wL/pq	Rent to k	wL/pq
.084	76.4	.125	74.9
.141	74.4	.203	73.0
.216	72.8	.305	71.4
.311	71.3	.430	70.0
.425	70.0	.580	68.7
.560	68.9	.755	67.6
.715	67.8	.956	66.5
.891	66.8	1.182	65.6
1.088	65.9	1.433	64.7
1.306	65.1	1.709	63.9

Table 1M.2. Production function: Technological change and factor substitutability (Part 2)

Parameters	Simulation 1 sigma = 0.5	Simulation 2 sigma = 0.8	Simulation 3 sigma = 1.2
sigma	.50	.80	1.20
a	25.00	25.00	25.00
alpha	.30	.30	.30
k	3.00	3.00	3.00
theta 0	1.00	1.00	1.00
theta k	1.00	1.00	1.00
theta L	1.00	1.00	1.00
-rho	-1.00	-.25	.17

Variation of production with labor input

Labor L	Production	Marginal productivity of L	Production	Marginal productivity of L	Production	Marginal productivity of L
2.00	55.6	21.6	56.2	20.3	56.6	19.4
3.00	75.0	17.5	75.0	17.5	75.0	17.5
4.00	90.9	14.5	91.5	15.7	91.9	16.3
5.00	104.2	12.2	106.5	14.3	107.7	15.5
6.00	115.4	10.4	120.3	13.3	122.9	14.8
7.00	125.0	8.9	133.1	12.4	137.4	14.3
8.00	133.3	7.8	145.2	11.7	151.5	13.9
9.00	140.6	6.8	156.6	11.1	165.2	13.5
10.00	147.1	6.1	167.5	10.6	178.6	13.2

Optimal behavior

Factor demand and supply function

Price	Wage	p/w	Labor demand	Output supply	Supply elasticity	Labor demand	Output supply	Supply elasticity	Labor demand	Output supply	Supply elasticity
.037	1.00	.037	1.05	33		.82	28.9		.61	25.8	
.042	1.00	.042	1.57	46	3.0	1.23	39.5	2.7	.95	34.3	2.4
.047	1.00	.047	2.07	57	2.0	1.74	50.8	2.4	1.42	44.9	2.6
.052	1.00	.052	2.54	67	1.6	2.32	62.5	2.2	2.07	58.1	2.8
.057	1.00	.057	2.99	75	1.3	2.98	74.7	2.0	2.97	74.5	2.9
.062	1.00	.062	3.42	82	1.1	3.71	87.0	1.9	4.18	94.9	3.1
.067	1.00	.067	3.83	88	1.0	4.52	99.5	1.8	5.81	120.1	3.3
.072	1.00	.072	4.22	94	.9	5.39	112.0	1.7	7.99	151.3	3.5
.077	1.00	.077	4.61	99	.8	6.32	124.5	1.6	10.86	189.9	3.7
.082	1.00	.082	4.98	104	.7	7.32	137.0	1.5	14.65	237.5	3.9

Technology

Capital/L	Output/L	Capital/L	Output/L	Capital/L	Output/L
2.9	31.1	3.7	35.4	4.9	42.1
1.9	29.2	2.4	32.0	3.2	36.2
1.4	27.6	1.7	29.2	2.1	31.6
1.2	26.2	1.3	27.0	1.4	28.0
1.0	25.0	1.0	25.1	1.0	25.1
.9	24.0	.8	23.4	.7	22.7
.8	23.1	.7	22.0	.5	20.7
.7	22.3	.6	20.8	.4	18.9
.7	21.5	.5	19.7	.3	17.5
.6	20.9	.4	18.7	.2	16.2

Return to fixed factor and income distribution

Rent to k	wL/pq	Rent to k	wL/pq	Rent to k	wL/pq
.052	87.0	.084	76.4	.114	64.2
.118	81.6	.141	74.4	.164	65.8
.204	77.2	.216	72.8	.230	67.3
.307	73.4	.311	71.3	.315	68.7
.425	70.1	.425	70.0	.425	70.0
.556	67.2	.560	68.9	.566	71.2
.698	64.6	.715	67.8	.744	72.3
.850	62.4	.891	66.8	.969	73.3
1.011	60.3	1.088	65.9	1.252	74.3
1.181	58.4	1.306	65.1	1.607	75.2

Table 1M.3. Production function: Technological change and factor substitutability (Part 3)

Parameters	Simulation 1 sigma = 0.5	Simulation 2 sigma = 0.8	Simulation 3 sigma = 1.2
sigma	.50	.80	1.20
a	25.00	25.00	25.00
alpha	.30	.30	.30
k	3.00	3.00	3.00
theta 0	1.00	1.00	1.00
theta k	1.00	1.00	1.00
theta L	1.00	1.00	1.00
-rho	-1.00	-.25	.17

Variation of production with labor input

Labor L	Production	Marginal productivity of L	Production	Marginal productivity of L	Production	Marginal productivity of L
2.00	55.6	21.6	56.2	20.3	56.6	19.4
3.00	75.0	17.5	75.0	17.5	75.0	17.5
4.00	90.9	14.5	91.5	15.7	91.9	16.3
5.00	104.2	12.2	106.5	14.3	107.7	15.5
6.00	115.4	10.4	120.3	13.3	122.9	14.8
7.00	125.0	8.9	133.1	12.4	137.4	14.3
8.00	133.3	7.8	145.2	11.7	151.5	13.9
9.00	140.6	6.8	156.6	11.1	165.2	13.5
10.00	147.1	6.1	167.5	10.6	178.6	13.2

Optimal behavior

Factor demand and supply function

Price	Wage	p/w	Labor demand	Output supply	Supply elasticity	Labor demand	Output supply	Supply elasticity	Labor demand	Output supply	Supply elasticity
.057	.75	.076	4.53	98.3		6.13	122.0		10.22	181.5	
.057	.80	.071	4.17	93.3		5.25	110.1		7.62	146.2	
.057	.85	.067	3.83	88.5		4.53	99.6		5.84	120.4	
.057	.90	.063	3.53	83.8		3.92	90.3		4.57	101.1	
.057	.95	.060	3.25	79.2		3.41	82.0		3.65	86.2	
.057	1.00	.057	2.99	74.8		2.98	74.7		2.97	74.5	
.057	1.05	.054	2.75	70.5		2.61	68.0		2.45	65.1	
.057	1.10	.052	2.52	66.2		2.30	62.1		2.05	57.5	
.057	1.15	.050	2.31	62.1		2.03	56.7		1.73	51.3	
.057	1.20	.048	2.12	58.1		1.79	51.9		1.48	46.1	

Technology

Capital/L	Output/L	Capital/L	Output/L	Capital/L	Output/L
.7	21.7	.5	19.9	.3	17.8
.7	22.4	.6	21.0	.4	19.2
.8	23.1	.7	22.0	.5	20.6
.9	23.7	.8	23.0	.7	22.1
.9	24.4	.9	24.0	.8	23.6
1.0	25.0	1.0	25.1	1.0	25.1
1.1	25.6	1.1	26.0	1.2	26.6
1.2	26.3	1.3	27.0	1.5	28.1
1.3	26.8	1.5	28.0	1.7	29.7
1.4	27.4	1.7	29.0	2.0	31.2

Return to fixed factor and income distribution

Rent to k	wL/pq	Rent to k	wL/pq	Rent to k	wL/pq
.734	60.7	.785	66.1	.893	74.1
.661	62.7	.691	67.0	.746	73.2
.595	64.6	.609	67.8	.634	72.3
.533	66.5	.539	68.6	.548	71.5
.477	68.3	.478	69.3	.480	70.7
.425	70.1	.425	70.0	.425	70.0
.377	71.8	.378	70.7	.380	69.3
.333	73.5	.338	71.4	.343	68.6
.293	75.2	.302	72.0	.311	68.0
.256	76.8	.270	72.6	.285	67.5

Exercise 2

Food Subsidies in Morocco

1. Contrast the budget shares of the different commodities. Which of the two grains is a necessity and which a luxury? Estimate the income elasticities.

Trends in budget shares show soft wheat consumption to decline and hard wheat to increase as income increases (Figure 2M.1). This indicates that soft wheat is a necessity and hard wheat a luxury good. Figure 2M.2 shows the share of the budget attributed to consumption of basic foods declines with income.

See elasticities in Table 2M.1.

2. Compute the price elasticities.

See results in Table 2M.1.

3. What does the ratio c/w suggest for the redesign of the food subsidy scheme if we want to protect the calorie intake of the rural poor while reducing the cost to government?

Among the food items specified in this model, barley has by far the highest *c/w* ratio, which is the calorie content per unit of expenditure. Subsidizing barley is therefore the most efficient means of getting the most calorie intake per unit of government expenditure.

4. Experiment 1: Eliminate the food subsidy on soft wheat. What are the effects on real income, calorie intake, and the government's subsidy budget?

Eliminating the soft wheat subsidy has a negative impact on real income (–4.7%) and calorie intake (–3.9%), while the rate of deficit reduction is above 55% (Table 2M.2). This is a little more than the 54% share of the wheat subsidy, as there is a slight decline in consumption of edible oils, which are also subsidized. As seen in row *dq/q*, consumption shifts out of soft wheat into hard wheat and barley (computed in row 93, then copied in row 118).

Experiment 2: Eliminate the subsidy on edible oils. How do the implications differ from the impact of eliminating the food subsidy on soft wheat and why?

Eliminating the subsidy on edible oils lessens the impact on real income and calorie intake because oil takes a lower share of the budget and has a lower price elasticity than wheat. There is also less restructuring of the consumption structure. At the same time, the decline in government expenditures is much lower (–31.7%).

Experiment 3: While eliminating the food subsidy on edible oils, introduce a subsidy to barley. By how much would you have to lower the price of barley in order to keep constant the nutritional status of the rural poor? Does it create significant savings for government?

The level of calorie intake is maintained by lowering the price of barley by almost 53%. With this price structure, real income declines by less than 1%, and consumption of hard wheat and barley increases while consumption of soft wheat and edible oils declines. Government expenditures are reduced by 13.1%.

Experiment 4: Eliminate the food subsidy on soft wheat instead of that on edible oils and protect the nutritional status of the poor by subsidizing barley. By how much do you need to lower the price of barley?

The price of barley must decrease by almost 60%. Real income declines by a little more than 2%.

Which of these alternative subsidy schemes would you recommend to the Moroccan government?

Judged by the three policy criteria studied in the simulation above, policy 3 (eliminating the subsidy on edible oils coupled with introducing a subsidy on barley) appears recommendable even without outside pressure to reduce overall government expenditure on food subsidies. It has little negative impact on real income, maintains the nutritional status of the rural poor, and allows for some reduction in government expenditures. In a sense, the policy corrects a current misallocation of subsidies. If, however, government expenditures need to be reduced by more than 13%, reduction of the wheat subsidy becomes necessary. In that case, the fourth policy is better than policy 2. It performs equally well on government budget and real income but is much better in terms of minimizing any reduction in calorie intake by the poor. However, this policy induces a dramatic substitution of soft wheat for barley, and people may not easily reduce the consumption of their primary staple by almost 50%. One can also expect political outcry in response to the important reduction in real income. Note, however, that the political consequences would be better measured by looking at groups which are politically more vocal than the rural poor, such as the urban poor and middle-income groups.

Figure 2M.1. Budget shares by deciles for soft and hard wheat

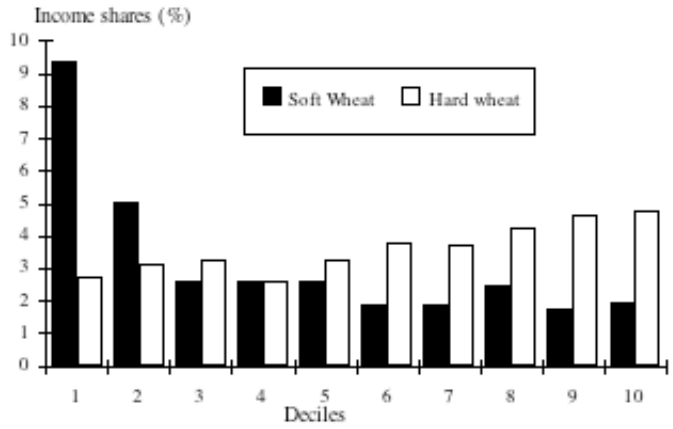
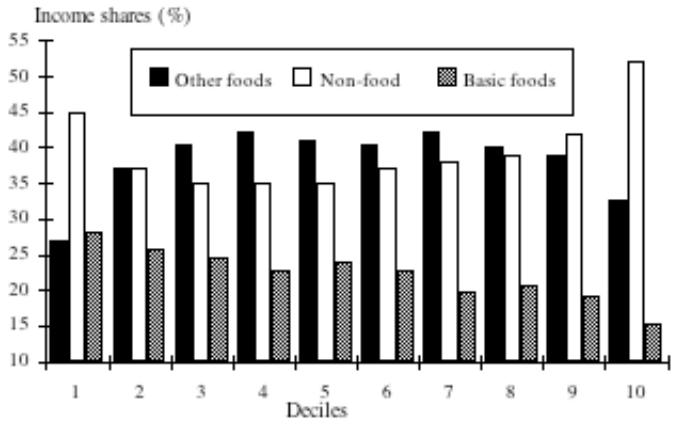


Figure 2M.2. Budget shares by deciles for basic foods, other foods, and nonfood



	A	B	C	D	E	F	G	H	I	J
1	**Table 2M.1. Food subsidies in Morocco**									
2										
3										
4			Soft	Hard						Total
5			wheat	wheat	Barley	Edible oils	Sugar	Other foods	Nonfoods	expenditure
6										
7	**Household expenditures (1984 dirhams)**									
8		Income deciles								
9		1 poorest	230	68	95	135	162	662	1105	2456
10		2	232	145	203	290	319	1711	1703	4603
11		3	163	203	285	447	447	2521	2190	6256
12		4	203	203	355	507	507	3293	2728	7795
13		5	243	304	426	669	608	3831	3274	9355
14		6	210	420	490	700	700	4482	4113	11115
15		7	249	499	499	748	665	5653	5095	13409
16		8	399	698	598	897	797	6579	6373	16342
17		9	362	966	604	1087	966	8090	8744	20818
18		10 richest	754	1885	754	1319	1319	12817	20419	39267
19										
20	**Logarithm of expenditures**									
21		Income deciles								
22		1 poorest	5.44	4.21	4.55	4.91	5.09	6.50	7.01	7.81
23		2	5.45	4.98	5.31	5.67	5.77	7.44	7.44	8.43
24		3	5.09	5.31	5.65	6.10	6.10	7.83	7.69	8.74
25		4	5.31	5.31	5.87	6.23	6.23	8.10	7.91	8.96
26		5	5.49	5.72	6.05	6.51	6.41	8.25	8.09	9.14
27		6	5.35	6.04	6.19	6.55	6.55	8.41	8.32	9.32
28		7	5.52	6.21	6.21	6.62	6.50	8.64	8.54	9.50
29		8	5.99	6.55	6.39	6.80	6.68	8.79	8.76	9.70
30		9	5.89	6.87	6.40	6.99	6.87	9.00	9.08	9.94
31		10 richest	6.63	7.54	6.63	7.18	7.18	9.46	9.92	10.58
32										
33	**Budget shares (w)**									
34		Income deciles								
35		1 poorest	0.09	0.03	0.04	0.06	0.07	0.27	0.45	1.00
36		2	0.05	0.03	0.04	0.06	0.07	0.37	0.37	1.00
37		3	0.03	0.03	0.05	0.07	0.07	0.40	0.35	1.00
38		4	0.03	0.03	0.05	0.07	0.07	0.42	0.35	1.00
39		5	0.03	0.03	0.05	0.07	0.07	0.41	0.35	1.00
40		6	0.02	0.04	0.04	0.06	0.06	0.40	0.37	1.00
41		7	0.02	0.04	0.04	0.06	0.05	0.42	0.38	1.00
42		8	0.02	0.04	0.04	0.05	0.05	0.40	0.39	1.00
43		9	0.02	0.05	0.03	0.05	0.05	0.39	0.42	1.00
44		10 richest	0.02	0.05	0.02	0.03	0.03	0.33	0.52	1.00
45										
46	**Estimated elasticities for rural decile 1**									
47										
48		Income elasticities (e)								Weighted sum
49		w decile 1	0.09	0.03	0.04	0.06	0.07	0.27	0.45	1.00
50		Estimated e	0.43	1.23	0.75	0.82	0.73	1.06	1.06	0.96
51		Calibrated e decile 1	0.45	1.28	0.78	0.86	0.76	1.10	1.11	1.00
52										
53		Price elasticities (E)								
54		Flexibility of money	-4							
55		Soft wheat						-0.09	-0.15	
56		Hard wheat						-0.25	-0.42	
57		Barley						-0.15	-0.25	
58		Edible oils						-0.17	-0.28	
59		Sugar						-0.15	-0.25	
60		Other foods	-0.09	-0.02	-0.03	-0.05	-0.06	-0.49	-0.36	
61		Nonfoods	-0.09	-0.02	-0.03	-0.05	-0.06	-0.22	-0.64	
62										

	A	B	C	D	E	F	G	H	I	J
63	**Table 2M.2. Food subsidies in Morocco: Policy analysis**									
64	Decrease the food subsidies budget while protecting nutritional status of the poor (poorest decile rural households)									
65										
66			Soft	Hard						
67			wheat	wheat	Barley	Edible oils	Sugar	Other foods	Nonfoods	Total
68										
69	**Initial structure of consumption and subsidies**									
70		Budget shares (w)	0.09	0.03	0.04	0.06	0.07	0.27	0.45	1.00
71		Calorie shares (c)	0.27	0.09	0.31	0.14	0.12	0.07	0.00	1.00
72		Subsidy shares (b)	0.54	0.00	0.00	0.32	0.10	0.04	0.00	1.00
73		c/w	2.89	3.27	8.05	2.55	1.82	0.26	0.00	
74		Income elasticities (e)	0.45	1.28	0.78	0.86	0.76	1.10	1.11	1.00
75		Subsidies budget (B)	115			68				212
76										
77										
78	**Calibrated price elasticities**									
79										
80		Soft wheat	-0.75	0.09	0.17	-0.02	0.02	0.03	0.01	
81		Hard wheat	0.23	-0.35	0.06	0.24	-0.48	-0.42	-0.57	
82		Barley	0.38	0.06	-0.36	-0.05	0.08	-0.38	-0.50	
83		Edible oils	-0.07	0.13	-0.04	-0.61	0.18	-0.18	-0.28	
84		Sugar	0.00	-0.19	0.05	0.16	-0.55	-0.07	-0.15	
85		Other foods	-0.05	-0.04	-0.07	-0.05	-0.04	-0.48	-0.38	
86		Nonfoods	-0.06	-0.03	-0.06	-0.05	-0.05	-0.23	-0.64	
87										
88	**Worksheet for policy experiment**									
89										
90		**Policy instruments**								
91		dp/p exogenous	0.50	0.00	0.00	0.00	0.00	0.00	0.00	
92		**Endogenous changes**								
93		dq/q	-0.38	0.12	0.19	-0.03	0.00	-0.02	-0.03	
94		ds/s	-1.00	0.00	0.00	0.00	0.00	0.00	0.00	
95		dS/S	-1.00	0.12	0.19	-0.03	0.00	-0.02	-0.03	
96										
97	**Results of policy experiment: Indicators of real income, calorie, and budget cost**									
98										
99		100*dy/y	-4.68		y is the real income of rural decile 1					
100		100*dqc/qc	3.91		qc is the calorie intake of rural decile 1					
101		100*dB/B	-55.17		B is the government budget on food subsidies to rural decile 1					
102										
103	**Record of results: Alternative subsidy schemes**									
104										
105		Experiments	1	2	3	4				
106		**Exogenous price changes**								
107		dp/p wheat	0.50			0.50				
108		dp/p barley			-.527	-.595				
109		dp/p oils		0.50	0.50					
110		**Endogenous policy criteria**								
111		100*dy/y	-4.68	-2.75	-0.72	-2.38				
112		100*dqc/qc	-3.91	-3.46	0.00	0.00				
113		100*dB/B	-55.17	-31.74	-13.13	-27.96				

Exercise 3

Price Incentives and Public Goods for Indian Agriculture

1. Complete the table of price elasticities. Discuss complementarity/ substitutability between products and between factors. Contrast the elasticities of supply and factor use with respect to the two structural variables.

Results are given in Table 3M.1. Direct price elasticities of products are relatively low. There is substitutability in production between wheat and rice and between coarse cereals and rice, and slight complementarity between wheat and coarse cereals. Animal power and labor use are affected minimally by crop prices, perhaps as a result of the relatively fixed nature of these inputs if there is no active market. Tractor use responds strongly to wheat price and to its own price. Both nonprice factors have a strong impact on production, with wheat production responding more to extension of irrigation and rice more to the research and extension services. Note that research induces more tractor use and less of the other inputs, indicating a labor-saving bias in research. Irrigation, on the other hand, induces higher use of tractor and labor as a consequence of the intensification of crop production.

2. Increase the price of rice by 10%. Comment on your results.

Increase in rice production largely comes from a substitution away from wheat, leaving a low aggregate supply response (~~0.3%~~ 0.014).

3. What is the impact of an exchange rate devaluation of 15% on agricultural production? Analyze the perverse effect of a devaluation on the utilization of tractors.

A devaluation induces a strong increase in production of tradables, with a small decrease in the production of the nontradable coarse cereals. As prices of rice and wheat increase, consumption should shift toward coarse cereals. An increase in demand combined with a decrease in supply of these coarse cereals would result in an increase in their price, illustrating the transmission of a price increase from tradables to nontradables, as discussed in the real exchange rate literature. Tractor use increases despite an increase in its price because of the very strong demand effect that the increase in crop production, wheat in particular, has on tractor use.

4. Simulate the effects of a 10% increase in each of the structural variables. Analyze the impact on the production structure and on total factor productivity of the variable factors.

Irrigation induces an increase in production of wheat, while research and extension induce an increase in rice production. With an increase in irrigation, factor use increases, although at a lower rate than crop production, indicating a certain total factor productivity increase. The results are much stronger with research and extension, which induce an overall decrease in factor use (with a very strong shift toward tractor use) despite production increases. This illustrates the very different natures of these two fixed factors, with irrigation intensifying production while research and extension reduce factor use.

5. Compare the long-run price elasticity of wheat production with the short-run elasticity of question 2.

With private investment responding to price, the long-run supply elasticity of wheat is 1.06, compared with the 0.36 short-run price elasticity.

6. With a model in which the public good increases the elasticity of supply response, calculate the direct price elasticity for wheat. Compare it with the simple elasticity obtained in question 2.

Direct price elasticity increases to 0.83 (Table 3M.2).

7. Analyze the decomposition of the total impact of public investment in its three effects.

A 10% increase in public investment (research and extension) has three effects on wheat production:

A direct effect of 7.3% growth (question 4, Table 3M.1).
If the impact on the price elasticity is included, this gives a 12% growth (col. 7a).
It also induces an increase in private investment (from 35 to 35.32).

All three effects combined give an increase in wheat production of 13.1% (col. 7b). This shows that the indirect effects are almost as important as the direct effect.

Table 3M.1. Price incentives and public goods in Indian agriculture

Parameters of the derived output supply and factor demand equations									Elasticities							
	Endogenous variables							Average base values exogenous variables								
Exogenous variables	Wheat	Rice	Coarse cereals	Bullock power	Tractor	Labor	Irrigation			Wheat	Rice	Coarse cereals	Bullock power	Tractor	Labor	Irrigation
Intercept	-18185	-3970	-520	-34677	568	1990	10.09									
Wheat price/wage	5441	-2133	450	-507	-200	-35	20.00	1.09	Wheat price	.36	-.20	.02	.02	.30	.00	.62
Rice price/wage	-2133	4569	-800	-277	-37	-3858		0.96	Rice price	-.12	.38	-.04	.01	.05	.12	.00
Coarse cereals price/wage	450	-800	2607	-147	-60	-1888		1.48	Coarse cereals price	.04	-.10	.18	.01	.12	.09	.00
Bullock price/wage	-507	-277	-147	430	-9	-1853		0.78	Bullock price	-.02	-.02	-.01	-.01	.01	.05	.00
Tractor price/wage	-200	-37	-60	-9	250	-6102		0.76	Tractor price	-.01	.00	.00	.00	-.27	.15	.00
Irrigation	531	90	175	-54	-20	-740		35.00	Irrigation	1.14	.27	.28	.06	.97	.86	.00
Research and extension	56	55	60	18	-2	30	.015	214.00	Research-extens.	.73	1.02	.59	-.12	.60	-.21	.09
Research*wheat price/wage								232.19								
									Wage	-.24	-.05	-.16	-.02	-.22	-.42	-.62
Estimated base values (endogenous variables)	16360	11586	21857	-33418	-718	-30111	35.00									

.		Quest.#2 Wheat p	Quest.#2 Rice p	Quest.#3 Tradables	Quest.#4 Irrigation	Quest.#4 Res&Ext	Quest.#5 Wheat p
Exogenous variables		10%	10%	15%	10%	10%	10%LR
Wheat price/wage	1.09	1.19	1.09	1.25	1.09	1.09	1.19
Rice price/wage	.96	.96	1.05	1.10	.96	.96	.96
Coarse cereals/wage	1.48	1.48	1.48	1.48	1.48	1.48	1.48
Bullock price/wage	.78	.78	.78	.78	.78	.78	.78
Tractor price/wage	.76	.76	.76	.88	.76	.76	.76
Irrigation	35.00	35.00	35.00	35.00	38.50	35.00	37.17
Research and extension	214	214	214	214	214	235	214
Research*wheat price/wage	232	255	232	267	232	255	255
Endogenous variables							
Wheat	16360	16950	16156	16916	18218	17558	18102
Rice	11586	11355	12024	11891	11901	12763	11550
Coarse cereals	21857	21906	21780	21808	22470	23141	22286
Total crops	61133	61624	61217	61957	64356	65457	63622
Bullock	-33418	-33473	-33445	-33541	-33607	-33033	-33590
Tractor	-718	-740	-722	-727	-788	-761	-783
Labor	-30111	-30115	-30481	-31369	-32701	-29469	-31721
Total factors	-56791	-56854	-57184	-58152	-59582	-55880	-58585
Profit/wage	4342	6608	5185	8183	4773	9577	7001
Percent change over base value							
Wheat	.00	3.61	-1.25	3.40	11.36	7.33	10.65
Rice	.00	-2.00	3.78	2.63	2.72	10.16	-.31
Coarse cereals	.00	.22	-.35	-.22	2.80	5.87	1.96
Total crops	.00	.80	.14	1.35	5.27	7.07	4.07
Bullock	.00	.16	.08	.37	.57	-1.15	.52
Tractor	.00	3.02	.49	1.29	9.75	5.96	9.07
Labor	.00	.01	1.23	4.18	8.60	-2.13	5.35
Total factors	.00	.11	.69	2.40	4.91	-1.60	3.16
Profit/wage	.00	52.21	19.42	88.48	9.94	120.58	61.25
Estimated irrigation	35.00	37.17	35.00			35.32	

Table 3M.2. Price incentives and public goods in Indian agriculture

Parameters of the derived output supply and factor demand equations									Elasticities							
	Endogenous variables							Average base values exogenous variables								
Exogenous variables	Wheat	Rice	Coarse cereals	Bullock power	Tractor	Labor	Irrigation			Wheat	Rice	Coarse cereals	Bullock power	Tractor	Labor	Irrigation
Intercept	-25847	-3970	-520	-34677	568	1990	10.09									
Wheat price/wage	5441	-2133	450	-507	-200	-35	20.00	1.09	Wheat price	.36	-.20	.02	.02	.30	.00	.62
Rice price/wage	-2133	4569	-800	-277	-37	-3858		0.96	Rice price	-.12	.38	-.04	.01	.05	.12	.00
Coarse cereals price/wage	450	-800	2607	-147	-60	-1888		1.48	Coarse cereals price	.04	-.10	.18	.01	.12	.09	.00
Bullock price/wage	-507	-277	-147	430	-9	-1853		0.78	Bullock price	-.02	-.02	-.01	-.01	.01	.05	.00
Tractor price/wage	-200	-37	-60	-9	250	-6102		0.76	Tractor price	-.01	.00	.00	.00	-.27	.15	.00
Irrigation	531	90	175	-54	-20	-740		35.00	Irrigation	1.14	.27	.28	.06	.97	.86	.00
Research and extension	56	55	60	18	-2	30	.015	214.00	Research-extension	.73	1.02	.59	-.12	.60	-.21	.09
Research*wheat price/wage	33							232.19								
									Wage	-.24	-.05	-.16	-.02	-.22	-.42	-.62
Estimated base values	16360	11586	21857	-33418	-718	-30111	35.00									
(endogenous variables, values in constant prices)																

Simulations		Quest.#6 Wheat p	Quest.#7a Res&Ext	Quest.#7b Res&Ext
Exogenous variables		10%	10%	10%LR
Wheat price/wage	1.09	1.19	1.09	1.09
Rice price/wage	.96	.96	.96	.96
Coarse cereals price/wage	1.48	1.48	1.48	1.48
Bullock price/wage	.78	.78	.78	.78
Tractor price/wage	.76	.76	.76	.76
Irrigation	35.00	35.00	35.00	35.32
Research and extension	214	214	235	235
Research*wheat price/wage	232	255	255	255
Endogenous variables				
Wheat	16360	17716	18324	18494
Rice	11586	11355	12763	12792
Coarse cereals	21857	21906	23141	23197
Total crops	61133	62455	66288	66583
Bullock	-33418	-33473	-33033	-33050
Tractor	-718	-740	-761	-767
Labor	-30111	-30115	-29469	-29706
Total factors	-56791	-56854	-55880	-56136
Profit/wage	4342	7523	10408	10447
Percent change over base value				
Wheat	.00	8.29	12.01	13.05
Rice	.00	-2.00	10.16	10.41
Coarse cereals	.00	.22	5.87	6.13
Total crops	.00	2.16	8.43	8.92
Bullock	.00	.16	-1.15	-1.10
Tractor	.00	3.02	5.96	6.85
Labor	.00	.01	-2.13	-1.35
Total factors	.00	.11	-1.60	-1.15
Profit/wage	.00	73.27	139.72	140.63
Estimated irrigation	35.00	37.17	35.32	

Exercise 4

Supply Response for Groundnuts in Sub-Saharan Africa

1. Data preparation.

See Table 4M.1.

2. Describe the evolution of acreage and price. What does it suggest in terms of the role of price incentive? In which periods does it seem that the acreage decision may have been affected by something other than the groundnut price?

The graphs of real groundnut price and planted area (Figure 4M.1) show reasonably parallel movements, with declines in 1960–66, upward trends in 1967–73, and again declines since 1974. This indicates that real prices may have been an important determinant of the planting decision. Exceptions are in 1967, when the negative trend in planted area turned around while groundnut price was still falling, and in an exceptionally low year in 1974. There seems also to be a much stronger fall in planted area in 1983–88 than would be expected from the continuing trend of price alone, indicating that some other factors are negatively affecting groundnut production. We will see if this can be attributed to adjustment policies implemented since 1979.

3. Estimate different models. Compare the economic results and the statistical qualities of the alternative specifications. Discuss the sign of the parameters. What are the elements of a structural adjustment policy that should act negatively on groundnut production, and what are those that should act positively?

The results reported in Table 4M.2 and Figure 4M.2 show a relatively good fit with all five specifications, with R^2 ranging from 0.82 to 0.89 (adjusted R^2 are a little lower but ranked in the same order). The direct price elasticity is positive and significantly different from zero in all regressions. These price elasticities are higher in the first two models (0.35 and 0.34) than when a structural adjustment variable is included. Because both lower prices and adjustment policy occurred simultaneously in the second period, the negative effect of the adjustment policy is mistaken as a price effect in the first two regressions. The cross-price elasticities with respect to millet price are all negative and significant, indicating a strong competition between these two products. While the last year's rainfall variable is barely positive, the less erratic three-year average has a significant impact on the farmers' decision to plant groundnuts.

All adjustment variables are strongly significant. The expected impact of a liberalization/stabilization package contains contradictory effects. The retrenchment of the government from its supportive activities (input supply, input subsidy, marketing, extension services, and reduction of uncertainty and price stabilization by guaranteed prices) negatively affects producers and should induce a reduction of the production of the most affected crops. At the same time, this leaves the prices as the main determinants of profitability; this should increase the price responsiveness of producers. Since the groundnuts price has continued to decrease (although at a

lower rate) during this period, both phenomena cumulate to induce a sharp decrease in production. The high price responsiveness can be inferred from the very sharp movements of planted area between 1979 and 1983, corresponding to similar but less accentuated price movements. Results confirm these expectations. When either one of the two adjustment variables is introduced, it is significant and negative; in fact, the results of models 3 and 4 are very similar. When both of them are simultaneously used, the results show a negative effect of the additive dummy (–4.87), while the multiplicative dummy has a positive parameter (0.502). Using the estimated equation:

$$\ln A_t = b_0 + b_1 \ln \hat{A}_{t-1} + (.18 + .50 DUM_t) \ln P_{gt} + b_3 \ln P_{m,t-1} + b_4 \ln R_{t-1} - 4.87 DUM_t,$$

the introduction of the adjustment program (DUM = 1 instead of 0) induces an increase of the short- (long-) run price elasticity from 0.18 to 0.68 (0.44 to 1.7) and an average shift of the supply curve. To measure this last effect, one has to compute the induced change in the average value of $\ln A_t$, which is equal to $-4.87 + 0.50\ \overline{\ln P_{gt}} = 0.90$, where $\overline{\ln P_{gt}}$ is the average value of $\ln P_{gt}$ during the 1979–88 period. Thus, A_t decreased by 10% in average during the 1979–88 period.

4.1 Calculate the short- and long-run elasticities for your model.

See Table 4M.2.

4.2 What is the impact of the price policy under structural adjustment? What would be the impact of the price policy without structural adjustment? Does structural adjustment make price policies more or less necessary than in normal times? Explain why.

The effect of a potential higher price for groundnuts in the context of a structural adjustment program is analyzed by simulating planted areas with model 5. (Note that the simulated value $\hat{A}_{t-1}$, rather than the observed value A_{t-1}, must be used for the computation of $\hat{A}_t$.) Columns L, M, and N of Table 4M.1 and the corresponding graphs (Figure 4M.3) show the impact of an increase in price alone (L), a removal of the structural adjustment program (M), and both effects together (N). From these, impact of the price increase with (col. L compared with col. J) and without (col. N compared with col. M) structural adjustment is computed in columns O and P. In the absence of structural adjustment, the increase in area grows from 2.5% in the short run to 6.30% in the long run. These numbers correspond to the product of the price change (15%) by the short- and long-run elasticities (0.17 and 0.44). With structural adjustment in place, the elasticities and, thus, the induced growth in area are greater.

This analysis shows that, while an adjustment has a negative effect on groundnuts production, it increases the producers' price responsiveness. In the particular case that we have studied, since a price decrease happened in the period of adjustment, both effects cumulate in a substantial reduction of production.

Figure 4M.1. - Area and real price for groundnuts in Sub-Saharan Africa

Figure 4M.2. - Observed and predicted areas for groundnuts in Sub-Saharan Africa

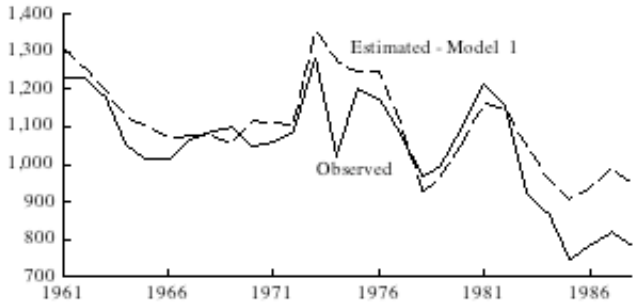
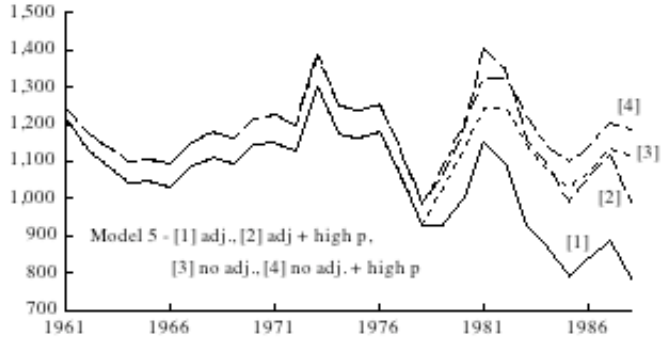


Figure 4M.3. - Price policy with and without structural adjustment



	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
41	**Table 4M.1. Supply response for groundnuts in Sub-Saharan Africa: Data preparation and simulation results**															
42																
43							Previous	Agricultural	Estimated area			Estimated area in groundnuts under alternative policy				
44		Area in	Lag	Prices (1961 CFA)		Rainfall	three-year	structural	in groundnuts		High price of	High price	No	High price	High price	High price
45		groundnuts	area in		Last year	last	mean	adjustment		Best	groundnuts	with	structural	without	with	without
46	Year	(1,000 ha)	groundnuts	Groundnut	millet	year	rainfall	1979 - 88	Model 1	model ?	new Pgt	struct. adj.	adjustment	struct. adj.	struct. adj.	struct. adj.
47	t	ln At	ln At-1	ln Pgt	ln Pm,t-1	ln Rt-1	ln Rt-(1-3)	DUM	(1,000 ha)		(CFA/mt)	(1,000 ha)	(1,000 ha)	(1,000 ha)	(percent change)	
48	1960	7.19		9.98					1323	1323	24900	1323	1323	1323		
49	1961	7.11	7.19	10.00	10.05	6.71		0	1312	1215	25300	1245	1215	1245	2.50	2.50
50	1962	7.12	7.11	9.91	10.02	6.53		0	1257	1135	23116	1181	1135	1181	4.02	4.02
51	1963	7.08	7.12	9.85	9.98	6.41	6.56	0	1201	1087	21704	1141	1087	1141	4.94	4.94
52	1964	6.96	7.08	9.74	10.00	6.55	6.50	0	1129	1043	19595	1100	1043	1100	5.49	5.49
53	1965	6.92	6.96	9.71	9.94	6.72	6.57	0	1108	1047	18861	1108	1047	1108	5.82	5.82
54	1966	6.92	6.92	9.70	9.93	6.49	6.59	0	1072	1033	18808	1095	1033	1095	6.01	6.01
55	1967	6.97	6.92	9.52	9.75	6.80	6.68	0	1078	1088	15729	1154	1088	1154	6.13	6.13
56	1968	6.99	6.97	9.53	9.77	6.79	6.70	0	1075	1113	15789	1182	1113	1182	6.20	6.20
57	1969	7.00	6.99	9.65	9.77	6.12	6.62	0	1053	1095	17848	1163	1095	1163	6.24	6.24
58	1970	6.96	7.00	9.70	9.77	6.73	6.59	0	1114	1144	18695	1216	1144	1216	6.26	6.26
59	1971	6.97	6.96	9.63	9.69	6.21	6.39	0	1111	1152	17581	1224	1152	1224	6.28	6.28
60	1972	6.99	6.97	9.68	9.86	6.61	6.54	0	1103	1127	18374	1198	1127	1198	6.29	6.29
61	1973	7.15	6.99	10.11	9.53	6.06	6.32	0	1356	1303	28190	1384	1303	1384	6.29	6.29
62	1974	6.93	7.15	9.97	9.99	6.13	6.30	0	1278	1173	24474	1247	1173	1247	6.29	6.29
63	1975	7.09	6.93	9.77	9.80	6.32	6.18	0	1248	1162	20163	1235	1162	1235	6.30	6.30
64	1976	7.07	7.09	9.71	9.78	6.69	6.41	0	1248	1180	18984	1254	1180	1254	6.30	6.30
65	1977	6.98	7.07	9.65	9.99	6.35	6.47	0	1103	1063	17848	1129	1063	1129	6.30	6.30
66	1978	6.88	6.98	9.58	10.10	6.08	6.40	0	931	929	16612	987	929	987	6.30	6.30
67	1979	6.90	6.88	9.50	9.66	6.46	6.31	1	971	929	15346	1059	1024	1089	14.02	6.30
68	1980	7.00	6.90	9.56	9.58	6.50	6.36	1	1052	1002	16340	1191	1134	1206	18.88	6.30
69	1981	7.10	7.00	9.69	9.46	6.04	6.35	1	1161	1153	18516	1405	1246	1324	21.87	6.30
70	1982	7.05	7.10	9.53	9.60	6.35	6.31	1	1151	1093	15789	1351	1243	1321	23.69	6.30
71	1983	6.83	7.05	9.42	9.75	6.32	6.24	1	1043	926	14148	1155	1148	1221	24.78	6.30
72	1984	6.77	6.83	9.53	9.77	5.82	6.19	1	963	867	15802	1087	1070	1137	25.44	6.30
73	1985	6.62	6.77	9.41	9.76	6.20	6.13	1	906	790	14002	994	1034	1099	25.83	6.30
74	1986	6.67	6.62	9.53	9.69	6.30	6.13	1	938	840	15826	1059	1070	1138	26.06	6.30
75	1987	6.71	6.67	9.49	9.63	6.60	6.38	1	992	885	15169	1117	1134	1206	26.20	6.30
76	1988	6.67	6.71	9.28	9.69	6.70	6.55	1	949	783	12305	988	1117	1187	26.28	6.30

Table 4M.2. Supply response for groundnuts in Sub-Saharan Africa: Regression results

	Dependent variable	Constant	Lag area ln At-1	Prices (1961 CFA) Current groundnut ln Pgt	Prices (1961 CFA) Millet ln Pm,t-1	Rainfall last year ln Rt-1	Three-year average ln Rt-(1-3)	Structural adjustment 1979 - 88 Additive DUM	Structural adjustment 1979 - 88 On price DUM*ln Pgt	R2 [adjusted]	Elasticities (at mean values) w.r.t. Groundnut price Short	Groundnut price Long	Millet price Short	Millet price Long
1.	lnAt	1.62	0.675	.349	-.341	.09				0.82	0.35	1.07	-0.34	-1.05
		(1.8)	(5.4)	(3.9)	(-3.9)	(1.8)				[.79]	{.35}	{1.07}		
2.	lnAt	1.67	0.621	.338	-.368		.202			0.83	0.34	0.89	-0.37	-0.97
		(1.6)	(5.0)	(3.7)	(-4.1)		(2.4)			[.79]	{.34}	{.89}		
3.	lnAt	4.19	0.646	.235	-.441	.05		-.092		0.85	0.24	0.66	-0.44	-1.25
		(2.9)	(5.5)	(2.4)	(-4.7)	(1.1)		(-2.2)		[.82]	{.24}	{.66}		
4.	lnAt	4.14	0.648	.239	-.441	.05			-.009	0.85	0.24	0.68	-0.44	-1.25
		(2.9)	(5.5)	(2.4)	(-4.7)	(1.1)			(-2.2)	[.82]	{.23}	{.65}		
5.	lnAt	4.29	0.595	.177	-.372	.08		-4.87	.502	0.89	0.18	0.44	-0.37	-0.92
		(3.3)	(5.5)	(2.3)	(-4.2)	(1.7)		(-2.5)	(2.4)	[.85]	{.68}	{1.68}		

Note: t-statistics in parentheses; elasticities with structural adjustment in curly brackets; adjusted R2 = 1–[T/(T–K)](1–R2), where T is the number of observations and K the number of exogenous variables.

Exercise 5

Food Security in India

1. Comment on the evolution of self-sufficiency.

Two periods are clearly distinguishable in the graph (Figure 5M.1), with a breaking point in the mid-1960s corresponding to the Green Revolution. From 1950 to 1966, India increased its imports dramatically, reaching a high level of dependency of almost 16%; it then decreased its imports to achieve self-sufficiency in the early 1970s.

2. Comment on India's food security policy on the basis of the evolution of food availability, production, imports, and stocks.

See Table 5M.1 and Figures 5M.2 and 5M.3. Food availability was always above production until 1975, indicating that imports were used to increase consumption above the production capacity of the country. Imports were also used in 1966 and 1967 to reduce the impact of the dramatic shortfall in production on consumption. They did not, however, completely protect the consumers, and we see an important decline in consumption in these two years. By contrast, since 1975, availability is rarely above production and sometimes below. Shortfalls in production were almost completely transmitted to consumption in 1973, 1975, and 1980. This indicates a decrease in the role of import policy in increasing and smoothing consumption. The graphs on imports and stocks also show the shift in instrument from imports to stocks in trying to smooth consumption. Imports have declined since 1966 and are almost nil since 1976, except in 1983. At the same time stocks have increased rapidly, reaching 24 million tons in 1984, which is more than twice as much as the peak imports of 1966. Their release in 1987 allowed consumption to be maintained despite a decline in production, but this was not done in 1980 when production was low.

3. Contrast the two periods regarding the growth and the variability of production.

With the Green Revolution, production increased at only a slightly higher rate than before (2.8% annually instead of 2.4%). This shows that the Green Revolution allowed the country to maintain, through yield increase, a level of growth that was previously based on land expansion. Fluctuations have somewhat decreased, probably as a result of extension of irrigation.

4. Compare the rate of growth and the variability of production and net food availability. Discuss your findings in terms of strategy choices for food security in India.

By contrast, the trend in food availability has decreased from 2.8% to 2.5%. This shows a drastic change in the policy of food security. Prior to 1966, imports were used to allow consumption to grow faster than domestic production. After 1966, the rise in domestic production was used to curtail imports. In fact, stockpiling and cuts in imports amounted to more than production growth, so that consumption did not grow as fast as production. Improvement in chronic food security slowed down in the post–Green Revolution period while food self-sufficiency dramatically improved.

Coefficients of variation of availability are smaller than those of production in both periods, indicating that the import and stock policies successfully stabilized consumption and, thus, increased transitory food security. Note that standard deviations and, thus, coefficients of variation, are calculated either as:

$$\sqrt{\sum_i (x_i - \bar{x})^2 / n} \text{ or as } \sqrt{\sum_i (x_i - \bar{x})^2 / (n-1)},$$

where n is the number of observations. The second formula applies when the observations consist of a sample population, while the first formula applies when the observations represent the entire population. The results given in Table 5M.1 are based on the first definition, which is more relevant for our case.

5. Discuss the evolution of per capita availability.

The same results are seen on the per capita observations. These more forcefully illustrate that the very successful production strategy based on the Green Revolution was only able to maintain the level of average food consumption per capita, not improve it.

6. Discuss the achievement in terms of price stabilization.

Indian foodgrain prices have decreased at an annual rate of 1.4% since 1967. This indicates that the very low improvement in chronic food security during this period is due to stagnation in demand and not inadequate supply.

At the same time, domestic prices exhibit a lower rate of decrease and a much lower instability than the international price (Figure 5M.4). This indicates a successful strategy in terms of both price support and stabilization, obtained through import controls and stocks policy. This successful price support strategy should also be related to the domestic situation. Accumulation of stocks reveals that the domestic prices are also maintained above the equilibrium market price of a closed economy.

Combining these results for the trends in consumption, stocks, and prices suggests that defining a successful food security strategy remains an urgent policy agenda. If this is to be achieved without a dramatic fall in domestic price that would hurt producers, it requires policies to improve income.

Figure 5M.1. Foodgrains import dependency

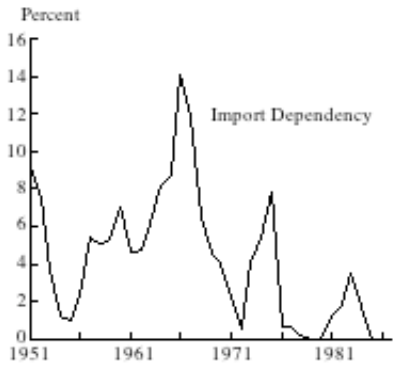


Figure 5M.2. Foodgrains production and availability

Figure 5M.3. Foodgrains imports and stocks

Figure 5M.4. International and domestic prices

	A	B	C	D	E	F	G	H	I	J	K	L	M
1	**Table 5M.1. Food security in India**												
4								**Prices**				**Price indices**	
6								Wholesale	price index	International			
7			Net		Closing stocks with	Net	Import dependency		All	price	Per capita net	Relative foodgrains	International price
8	Year	Population	production	Imports	government	availability	ratio	Foodgrains	commodities	(Thai rice)	availability	price index	(Thai rice)
9		(millions)		(million tons)			(percent)	(base 1970 - 71 = 100)		(1980 $)	(kg)	(base 1970 - 1971)	
11	1950				.7			44.5	48.5	604.9		96	158.1
12	1951	363.4	48.1	4.8	1.3	52.3	9.1	49.8	53.3	553.3	144	97	144.6
13	1952	369.6	48.6	3.9	2.0	51.8	7.4	48.2	45.5	572.5	140	110	149.6
14	1953	376.1	54.0	2.0	1.5	56.5	3.6	48.5	46.3	656.8	150	109	171.6
15	1954	382.9	63.2	.8	1.7	63.8	1.3	39.3	44.3	607.3	167	92	158.7
16	1955	390.2	61.8	.6	.9	63.2	1.0	33.9	40.7	534.0	162	87	139.6
17	1956	397.8	60.6	1.4	.3	62.6	2.3	43.7	45.7	499.6	157	100	130.6
18	1957	405.8	63.3	3.6	1.2	66.0	5.4	48.0	48.3	490.0	163	103	128.1
19	1958	414.3	59.2	3.2	.9	62.7	5.1	50.0	49.3	499.3	151	105	130.5
20	1959	423.3	68.9	3.9	1.4	72.3	5.4	50.4	51.3	470.5	171	102	123.0
21	1960	432.7	67.1	5.1	2.8	70.8	7.1	50.1	54.6	434.5	164	95	113.6
22	1961	442.4	71.8	3.5	2.6	75.5	4.7	48.5	55.9	467.5	171	90	122.2
23	1962	452.2	72.4	3.6	2.3	76.3	4.7	51.2	56.5	514.5	169	94	134.5
24	1963	462.0	70.1	4.6	2.3	74.7	6.2	54.0	58.9	490.8	162	95	128.3
25	1964	472.1	70.6	6.3	1.0	78.2	8.2	66.9	65.9	462.1	166	106	120.8
26	1965	482.5	78.2	7.5	2.1	84.6	8.8	72.4	71.7	454.3	175	105	118.7
27	1966	493.2	63.3	10.4	2.2	73.6	14.1	81.5	81.6	524.8	149	104	137.1
28	1967	504.2	65.0	8.7	2.0	73.9	11.8	106.5	94.1	655.4	146	118	171.3
29	1968	515.4	83.2	5.7	4.0	86.9	6.4	100.9	93.1	646.2	169	113	168.9
30	1969	527.0	82.3	3.9	4.5	85.7	4.5	89.5	95.4	569.8	163	98	148.9
31	1970	538.9	87.1	3.6	5.6	89.6	4.0	96.4	101.3	413.8	166	99	108.1
32	1971	551.3	94.9	2.0	8.1	94.4	2.1	102.1	105.2	351.5	171	101	91.9
33	1972	563.9	92.0	.5	3.4	97.2	.5	114.6	113.0	367.5	172	105	96.0
34	1973	576.8	84.9	3.6	3.1	88.8	4.1	135.0	131.6	754.3	154	107	197.1
35	1974	590.0	91.6	5.1	2.7	97.1	5.3	183.6	169.2	959.3	165	113	250.7
36	1975	603.5	87.4	7.4	7.9	89.6	7.8	187.0	175.8	578.2	148	111	151.1
37	1976	617.2	105.9	.7	18.8	95.7	.6	150.4	172.4	399.5	155	91	104.4
38	1977	631.3	97.3	.6	17.3	99.4	.6	167.2	185.4	388.9	157	94	101.6
39	1978	645.7	110.6	.2	17.1	111.0	.2	173.3	185.0	456.5	172	97	119.3
40	1979	660.3	115.4	.0	17.4	115.1	.0	179.8	206.5	363.3	174	91	94.9
41	1980	675.2	96.0	.0	11.7	101.7	.0	207.3	248.1	433.9	151	87	113.4
42	1981	690.1	113.4	1.2	11.3	115.0	1.0	236.1	278.4	480.4	167	88	125.5
43	1982	705.2	116.6	2.1	12.8	117.2	1.8	242.5	285.3	295.6	166	88	77.3
44	1983	720.4	113.3	4.1	15.3	114.9	3.5	270.4	308.5	286.6	160	91	74.9
45	1984	735.6	133.3	2.3	22.6	128.3	1.7	275.4	334.0	265.6	174	86	69.4
46	1985	750.9	127.4	.0	24.2	125.8	.0	289.5	353.3	225.1	167	85	58.8
47	1986	766.1	131.6	.0	22.6	133.2	.0			185.6	174		48.5
48	1987	781.4	124.4	.0	14.0	133.0	.0				170		

	A	B	C	D	E	F	G	H	I	J	K	L	M
49	Table 5M.1. (continued)												
50	Annual growth rates											1985 instead of 1987	
51	1951–66		2.4	9.8	4.0	2.8	7.0	3.3	3.3	-1.6	.75	.0	-1.6
52	1967–87		2.8	-35.8	10.4	2.5	-38.2	6.6	8.1	-4.5	.29	-1.5	-4.5
53	1951–87		2.6	-14.7	9.5	2.4	-17.1	6.3	6.6	-1.5	.21	-.3	-1.5
54	Coefficient of variation around trend												
55	1951–66		7.3	67.1	42.8	5.04	71.4	14.1	10.3	8.2	5.2	6.7	8.2
56	1967–87		7.0	2725.1	47.4	4.96	2666.2	11.5	6.9	32.2	5.0	5.8	31.7
57	1951–87		7.2	746.2	52.0	5.23	749.2	16.9	16.0	32.0	5.4	8.3	30.1
58													
59	Sources: Government of India, Bulletin on Food Statistics, 1965, 1985, and Economic Survey 1987 - 88;												
60	World Bank, Commodity Trade and Price Trends, 1987-88, (Baltimore: Johns Hopkins University Press, 1988).												
61													
62													
63	**Working space**												
64													
65	Year		Net production			Net availability		Per capita net			Relative foodgrains price		
66													
67				(Obs-est)			(Obs-est)	availability		(Obs-est)			(Obs-est)
68		Ln	Estimated	/est	Ln	Estimated	/est	Ln	Estimated	/est	Ln	Estimated	/est
69													
70													
71	1950												
72	1951	3.87	52.7	-0.088	3.96	54.4	-0.039	4.97	150.9	-0.047	4.58	99.3	-0.023
73	1952	3.88	54.0	-0.101	3.95	55.9	-0.074	4.94	152.0	-0.078	4.70	99.4	0.110
74	1953	3.99	55.3	-0.025	4.03	57.5	-0.018	5.01	153.1	-0.020	4.69	99.4	0.096

Exercise 6

Household Responses to Price Incentives

1. Agricultural price increases by 10%. What is the change in supply? In consumption? Compare the results given by the landless household model and by the landed household model.

The results show that when the agricultural price increases, landless households reduce their consumption of food, slightly increase the consumption of other commodities (substitution effect), and also reduce consumption of leisure to work more and compensate for the real income decrease. By contrast, the farm household benefits from the rise in food price. It increases production, which further increases its income; thus, the household can afford to consume more of everything, including food. Higher food prices reduce the net supply of labor coming from the farm household; the household demands more labor on its farm and works less as a result of increased leisure.

Compare the subfamily farm with a landless household of the same endowment. Simulate the impact of a 10% price increase of the nonagricultural commodity for a subfamily farm.

For the subfamily farm, farm income only represents 30% of full income. The increase in income induced by the increase in the agricultural price is not sufficient to maintain food consumption at the previous level. For the subfamily farm, the income effect is dominated by the substitution effect, and an increase of agricultural price induces a decrease in food consumption.

2. Compare the price elasticities of consumption given by the consumer and the household models.

The elasticities of consumption with respect to the nonagricultural price are the same for the two households, since a change in the price of the nonagricultural good does not affect production decisions.

The input (fertilizer and animal labor) prices have no effect on the landless household. They have the same effect on agricultural and nonagricultural consumption in the landed household because the effect on consumption is entirely channeled through decreased profits and income, and the LLES has unit income elasticity for all commodities. For example, an increase of 10% in the price of fertilizer induces a decrease of 2.1% of profit, 1.1% of full income, and hence 1.1% of consumption.

The increase of wage has opposite effects on the landless and the landed household. For the landless, labor is a source of income, and an increase in wage induces an increase in income and consumption of all commodities, including leisure. For the landed household, which is a net buyer of labor (labor demand is 931 days and family labor supply only 600 days), labor is a net cost. Hence, an increase in wage induces a decrease in income and consumption, and an increase of labor supply.

Note that the elasticities of labor demand and output supply with respect to the prices other than wage and output price are equal. This follows from the use of a Cobb-Douglas profit function.

3. Analyze the elasticity of marketed surplus with respect to the agricultural price. Explain the results of the "perverse" effect of a decline of the marketed surplus.

The price elasticity of marketed surplus is 1.3, which is larger than the price elasticity of production of 1.1. This is because when price increases, even if consumption increases, it increases by much less than production. However, a perverse case is obtained if the household increases its consumption by more than its production. For this to happen, supply needs to be very inelastic, and consumption must have a low price elasticity. This is simulated in Table 6M.2. Different combinations of the parameters of the profit functions are possible. This table illustrates the case in which the parameters for wage and fertilizer price are set at –0.13 and –0.05, respectively, and the parameters for animal and mechanical labor prices are set at –0.01. This gives a parameter of 0.20 for the agricultural price. To reproduce the initial level of profit, the intercept is decreased to 8.903. With these numbers, a 10% increase in the agricultural price induces a 1.9% increase in production, a 12.1% increase in profit, a 6.3% increase in total income, and a 6.6% increase in food consumption. As consumption represents 40% of production, the differential in growth between consumption and production is sufficient for market surplus to actually decline. While this case illustrates the possibility of such perverse effects, it represents a somewhat extreme scenario, with a very low supply elasticity (0.19), a high share of food in total consumption (26.5% of total income or 38% of nonleisure consumption), a low price elasticity of food (–0.019), and a high income elasticity of food (equal to 1 by choice of the LLES model).

4. Compare the response of the original family farm with that of the family farm under labor market failure.

Rebalancing the supply and demand of labor after a 10% increase of the agricultural price requires a 16.1% increase of the shadow price of labor. Agricultural production then falls by 1.6%. The reason for this is that the increase in agricultural price induces an increase in income and, hence, a preference by the household to decrease its labor supply (by 6.6% in the case of a perfect labor market). This is somewhat mitigated by the increase in the profitability of labor in agricultural production, but labor supply still declines.

An increase in the price of the nonagricultural good induces the household to work more; hence, it produces more in order to generate a higher income.

Table 6M.1. Household response to price incentives

Parameter values in equations

	Exogenous variables									
	Intercept	Agr. price (Pa)	Nonagric. price (Pna)	Price of labor (wage)	Animal labor price (Panimal)	Mechanical labor price (Pmech.)	Fertilizer price (Pfert)	Number dependents (Ad)	Quantity of capital (K)	Quantity of land (T)
Consumption										
Agricultural commodity	0.145	0.025	0.042	-0.067				0.063		
Nonag. commodity	0.580	0.042	0.139	-0.181						
Home time	0.275	-0.067	-0.181	0.248				-0.063		
Production										
Profit / Pa	10.550	1.112		-0.826	-0.045	-0.020	-0.221		0.072	0.928

	Base household		Subfamily farm		Elasticities for the base household				Family farm			Labor market failure	
Observed exogenous values		Pa +10%		Pa +10%	Pna	Panimal	P fert.	Wage	Base	Pa +10%	Pna +10%	Pa +10%	Pna +10%
Other income to landed (NT$)	-10000	-10000	-10000	-10000	-10000	-10000	-10000	-10000	-10000	-10000	-10000	-10000	-10000
Other income to landless (NT$)	28690	28690	5476	5476	28690	28690	28690	28690	18244	18244	18244	18244	18244
Time per worker (days)	365	365	365	365	365	365	365	365	365	365	365	365	365
Agric. commodity price (NT$/kg)	3.4	3.7	3.4	3.7	3.4	3.4	3.4	3.4	3.4	3.7	3.4	3.7	3.4
Nonag. commodity price (NT$/kg)	26.8	26.8	26.8	26.8	29.5	26.8	26.8	26.8	26.8	26.8	29.5	26.8	29.5
Home time price, wage (NT$/day)	33.6	33.6	33.6	33.6	33.6	33.6	33.6	37.0	33.6	33.6	33.6	39.0	32.6
Animal labor price (NT$/day)	46.7	46.7	46.7	46.7	46.7	51.4	46.7	46.7	46.7	46.7	46.7	46.7	46.7
Mechanical labor price (NT$/hour)	53.2	53.2	53.2	53.2	53.2	53.2	53.2	53.2	53.2	53.2	53.2	53.2	53.2
Fertilizer price (NT$/kg)	2.3	2.3	2.3	2.3	2.3	2.3	2.5	2.3	2.3	2.3	2.3	2.3	2.3
Number of workers	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7
Number of dependents	7.3	7.3	7.3	7.3	7.3	7.3	7.3	7.3	7.3	7.3	7.3	7.3	7.3
Quantity of capital (NT$)	43045	43045	17218	17218	43045	43045	43045	43045	31423	31423	31423	31423	31423
Quantity of land (ha)	1.00	1.00	0.40	0.40	1.00	1.00	1.00	1.00	0.73	0.73	0.73	0.73	0.73
Endogenous variables													
Landless household													
Total time value (NT$)	45377	45377	45377	45377	45377	45377	45377	49914	45377	45377	45377	52637	44015
Full income (NT$)	74067	74067	50853	50853	74067	74067	74067	78604	63621	63621	63621	70881	62259

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
45	**Table 6M.1. Household response to price incentives (end)**														
46		Consumption:													
47		Agricultural commodity (kg)	4432	4077	3043	2799	4520	4432	4432	4556	3807	3502	3882	3713	3837
48		Nonagric. commodity (kg)	1250	1261	858	866	1170	1250	1250	1276	1074	1083	1005	1136	995
49		Home time (days)	759	745	521	511	721	759	759	782	652	640	619	681	610
50		Labor supply (days)	592	606	830	839	630	592	592	568	699	711	731	669	740
53	Landed household														
54		Producer model													
55		Profit (NT$)	38690	47317	15476	18927	38690	38524	37883	35761	28244	34542	28244	30556	28963
56		Production (kg)	24033	26720	9613	10688	24033	23930	23532	22214	17544	19506	17544	17255	17991
57		Labor demand (days)	951	1163	380	465	951	947	931	799	694	849	694	648	734
58		Animal labor (days)	37	46	15	18	37	34	37	34	27	33	27	29	28
59		Mechanical labor (hours)	15	18	6	7	15	14	14	13	11	13	11	11	11
60		Fertilizer (kg)	3718	4547	1487	1819	3718	3702	3309	3436	2714	3319	2714	2936	2783
61															
62		Full income (NT$)	74067	82694	50853	54304	74067	73901	73260	75675	63620	69918	63620	73193	62979
63		Consumption:							0.989						
64		Agricultural commodity (kg)	4432	4552	3043	2989	4520	4423	4384	4387	3807	3848	3882	3834	3881
65		Nonagric. commodity (kg)	1250	1408	858	925	1170	1247	1237	1229	1074	1191	1005	1173	1006
66		Home time (days)	759	831	521	546	721	757	750	753	652	703	619	703	617
67		Total labor supply (days)	592	519	830	805	630	594	600	597	699	648	731	647	733
68															
69		Marketed surplus (kg)	19601	22169	6570	7699	19514	19508	19148	17827	13737	15657	13662	13421	14110
70		Net market labor supply (days)	-359	-644	449	339	-321	-354	-331	-202	4	-202	37	-1	-1
75				Comparing columns											
76				D to C	E to C	F to E	G to C	H to C	I to C	J to C	K to C	L to K	M to K	N to K	O to K
77	Growth rates in production														
78		Production		11.2	-60.0	11.2	.0	-.4	-2.1	-7.6	-27.0	11.2	.0	-1.6	2.5
79		Labor demand		22.3	-60.0	22.3	.0	-.4	-2.1	-16.0	-27.0	22.3	.0	-6.7	5.7
80		Profit		22.3	-60.0	22.3	.0	-.4	-2.1	-7.6	-27.0	22.3	.0	8.2	2.5
82	Growth rates in consumption														
83	Landless household														
84		Agricultural commodity		-8.0	-31.3	-8.0	2.0	.0	.0	2.8	-14.1	-8.0	2.0	-2.5	.8
85		Nonagric. commodity		.9	-31.3	.9	-6.4	.0	.0	2.1	-14.1	.9	-6.4	5.8	-7.3
86		Home time		-1.9	-31.3	-1.9	-5.0	.0	.0	3.1	-14.1	-1.9	-5.0	4.5	-6.4
87		Labor supply		2.4	40.2	1.2	6.4	.0	.0	-4.0	18.1	1.7	4.7	-4.2	6.0
89	Landed household														
90		Agricultural commodity		2.7	-31.3	-1.8	2.0	-.2	-1.1	-1.0	-14.1	1.1	2.0	.7	1.9
91		Nonagric. commodity		12.6	-31.3	7.7	-6.4	-.2	-1.1	-1.7	-14.1	10.9	-6.4	9.2	-6.3
92		Home time		9.6	-31.3	4.8	-5.0	-.2	-1.1	-.7	-14.1	7.9	-5.0	7.9	-5.3
93		Marketed surplus		13.1	-66.5	17.2	-.4	-.5	-2.3	-9.0	-29.9	14.0	-.5	-2.3	2.7
94		Net market labor supply		79.2	-225.0	-24.5	-10.6				-101.3				

Table 6M.2. Household response to price incentives: Perverse marketed surplus response

Parameter values in equations

	Exogenous variables									
	Intercept	Agr. price (Pa)	Nonagric. price (Pna)	Wage (wage)	Animal labor price (Panimal)	Mechanical labor price (Pmech.)	Fertilizer price (Pfert)	Number dependents (Ad)	Quantity of capital (K)	Quantity of land (T)
Consumption										
Agricultural commodity	0.720	0.260	0.042	-0.302				0.063		
Nonag. commodity	0.580	0.042	0.139	-0.181						
Home time	-0.300	-0.302	-0.181	0.483				-0.063		
Production										
Profit / Pa	8.903	0.200		-0.130	-0.010	-0.010	-0.050		0.072	0.928

Observed exogenous values	Base household	Pa +10%
Other income to landed (NT$)	-10000	-10000
Other income to landless (NT$)	28690	28690
Time per worker (days)	365	365
Agric. commodity price (NT$/kg)	3.4	3.7
Nonag. commodity price (NT$/kg)	26.8	26.8
Home time price, wage (NT$/day)	33.6	33.6
Animal labor price (NT$/day)	46.7	46.7
Mechanical labor price (NT$/hour)	53.2	53.2
Fertilizer price (NT$/kg)	2.3	2.3
Number of workers	3.7	3.7
Number of dependents	7.3	7.3
Quantity of capital (NT$)	43045	43045
Quantity of land (ha)	1.00	1.00
Endogenous variables		
Landless household		
Total time value (NT$)	45377	45377
Full income (NT$)	74067	74067
Consumption:		

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
45	**Table 6M.2. Household response to price incentives: Perverse marketed surplus response (end)**														
46															
47		Agricultural commodity (kg)	5231	5247											
48		Nonagric. commodity (kg)	1250	1261											
49		Home time (days)	678	614											
50		Labor supply (days)	673	736											
53	Landed household														
54		Producer model													
55		Profit (NT$)	38690	43378											
56		Production (kg)	13655	13918											
57		Labor demand (days)	150	168											
58		Animal labor (days)	8	9											
59		Mechanical labor (hours)	7	8											
60		Fertilizer (kg)	841	943											
61															
62		Full income (NT$)	74067	78755											
63		Consumption:			Share of agricultural commodity in expenditures					0.265					
64		Agricultural commodity (kg)	5231	5579	Consumption price elasticity			-0.019							
65		Nonagric. commodity (kg)	1250	1341	Share of consumption in production				0.401						
66		Home time (days)	678	653											
67		Total labor supply (days)	673	697											
68															
69		Marketed surplus (kg)	8424	8339											
70		Net market labor supply (days)	523	529											
75				Comparing columns											
76				D to C											
77	Growth rates in production														
78		Production		1.9											
79		Labor demand		12.1											
80		Profit		12.1											
82	Growth rates in consumption														
83	Landless household														
84		Agricultural commodity		.3											
85		Nonagric. commodity		.9											
86		Home time		-9.4											
87		Labor supply		9.4											
89	Landed household			6.3											
90		Agricultural commodity		6.6											
91		Nonagric. commodity		7.3											
92		Home time		-3.6											
93		Marketed surplus		-1.0											
94		Net market labor supply		1.2											

Exercise 7

Effects of Price Distortions and Investment in Research on Efficiency and Welfare

1. Calculate the levels of production (q^b), consumption (c^b), and exports (E^b).

Results are given in Table 7M.1. Potential production under free trade would be 8231 thousand tons, or 17% higher than actual production in the short run, 43% higher in the medium run, and over 100% higher in the long run. Under the world price, however, consumption would be 26% lower. In the short run, exports under free trade would be more than double actual exports under an export tax, and in the long run they would increase more than four times.

2. Analyze the welfare impact of taxation. According to these results, who gains and who loses from taxation? Is the net social loss large or small relative to the income transfers that taxation creates? Is the loss mainly on the consumer or the producer side? How much does government gain relative to this loss?

The tax creates a transfer from producers (negative change in producer surplus) to consumers and government. The net is, however, negative. This is the net social loss, which amounts to 16% of the value of the transfer. The efficiency losses due to distortions in consumption and production are approximately equal. The government captures about 30% of the producer loss.

3. Parametric alternatives for the short-, medium-, and long-run elasticities of response.

See Table 7M.1. Losses increase in the long run.

4. Who captures the benefits from technological change in an open economy? Qualitatively, how would this differ in a closed economy?

If the government earmarks 2% of the export tax revenues to research, production will increase by 526 thousand tons, or 7%. With no changes in consumption, all this increase in production is exported, and exports increase by 23%. Government revenues are equal to tax revenues (new level of exports*price*tax rate) net of research expenditures (2% of the former export tax revenues).

5. What is the overall impact of taxation and technological change?

With technological change, the net change in producer surplus decreases but is still negative. In the medium run, the overall welfare loss is 12.7% of the transfer from producers, but, as above, the costs are much larger in the long run.

6. What is the minimum share that must be returned to agriculture under the form of research to make the net social effect positive? Look at both medium- and long-run effects.

The government would have to divert 4.6% of its revenues in the medium term and 11% in the long run to exactly offset the negative impact of taxation in terms of overall social welfare. Any level of reinvestment above these thresholds would generate a net social gain. This illustrates a potential beneficial policy, where the government can levy taxes and generate revenues for other needs while compensating for its efficiency costs through the provision of public goods.

7. Does the rise in world price directly affect producers, consumers, or both? Who is the main gainer from this rise in prices? What does it do to agricultural research?

Since the domestic price does not change, producers and consumers are not directly affected by this world price increase. If computed as before, changes in producer surplus and consumer surplus would only express the fact that this domestic price regulation corresponds to higher transfers relative to what would have happened in a free-trade environment in which the world price would have been transmitted to the domestic price. Government revenue is the only direct beneficiary of the price change. However, since this allows a higher research budget, an indirect positive effect on producers comes from increased production. With the new tax income of $184,149, research induces an increase in production of 702 thousand MT, instead of the 526 formerly obtained. The net gain for the producer is then $46,236, and total social gain is $99,064.

8. Discuss the implications that the trade liberalization has on all sectors including the government budget. Why is the net social gain of taxation cum research now positive? Use this result to weigh the relative merits of investment in research financed by trade distortions relative to trade liberalization.

Trade liberalization generates an increase in production, a decrease in consumption, and a substantial increase in exports (4670 thousand MT instead of 2287). Thus, government revenues increase despite this decrease in taxation rate (a Laffer curve case). Compared to the first column, both consumer surplus and producer taxation are much lower, and the net social loss due to taxation is only 27,835 in comparison to the 118,088 in the former taxation scheme. With slightly higher taxation revenues and research allocations, the positive effect of research on production increases (technological change also applies to a larger production base). The net social gain of this taxation cum research scheme is now positive. This shows a case where some taxation may be beneficial to the agricultural sector if a sufficient proportion is returned to the sector in the form of public goods.

	A	B	C	D	E	F	G	H	I
1	**Table 7M.1. Effects of price distortions and investment in research on efficiency and welfare**								
2									
3									
4									
5			Supply elasticities (etas)			Budget alloc. to research		World market	
6		Structural features	Short run	Medium run	Long run	Medium run	Long run	price + 20%	NPC = 0.75
7									
8		Observed levels (in 1000 MT)							
9		Production q	7033	7033	7033	7033	7033	7033	8596
10		Consumption c	4746	4746	4746	4746	4746	4746	3926
11		Exports E	2287	2287	2287	2287	2287	2287	4670
12									
13		Price elasticities							
14		Supply etas	0.20	0.50	1.20	0.50	1.20	0.20	0.50
15		Demand etas	-0.30	-0.30	-0.30	-0.30	-0.30	-0.30	-0.30
16									
17		Trade policy							
18		Nominal protection coefficient NPC	0.54	0.54	0.54	0.54	0.54	0.45	0.75
19		Border price ($ per MT) pb	122	122	122	122	122	146	122
20		Domestic price p = NPC*pb	66	66	66	66	66	66	92
21		Tax rate t* = (pb - p)/p	0.85	0.85	0.85	0.85	0.85	1.22	0.33
22									
23		Potential levels at border prices							
24		Production qb	8231	10029	14222	10029	14222	8752	10029
25		Consumption cb	3533	3533	3533	3533	3533	3006	3533
26		Exports Eb	4698	6495	10689	6495	10689	5746	6495
27									
28		Welfare effects of			taxation ...			pw increase	.... taxation ....
29									
30		Net social loss in production NSLP	33622	84055	201731	84055	201731		21848
31		Net social loss in consumption NSLC	34033	34033	34033	34033	34033		5987
32		Net social loss NSL	67655	118088	235764	118088	235764		27835
33		Change in consumer surplus ΔCS	232312	232312	232312	232312	232312		113747
34		Change in producer surplus ΔPS	-428314	-478747	-596423	-478747	-596423		-284022
35		Change in government revenues ΔB	128346	128346	128346	128346	128346	184149	142441
36		Net social gain from taxation	-67655	-118088	-235764	-118088	-235764		-27835
37									
38		Technological change gains from			taxation ...			pw increase	.... taxation ....
39		Share of government tax revenues							
40		allocated to agricultural research k	0.02	0.02	0.02	0.05	0.11	0.02	0.02
41		Elasticity of technology generation a	0.80	0.80	0.80	0.80	0.80	0.80	0.80
42		Output effect of research b*q*(k*B)^a	526	526	526	1024	2056	702	698
43		New level of production	7559	7559	7559	8057	9089	7735	9294
44									
45		Welfare effects of technological change							
46		Change in producer surplus ΔPS	34638	34638	34638	67443	135470	46236	63910
47		Change in consumer surplus ΔCS	0	0	0	0	0	0	0
48		Change in government revenue ΔB	26940	26940	26940	51547	101282	52828	18455
49		Net social gain from techn. change	61578	61578	61578	118990	236752	99064	82365
50									
51		Net effects of technology and			taxation ...			pw increase	.... taxation ....
52									
53		Change in producer surplus	-393676	-444109	-561785	-411304	-460953	46236	-220112
54		Change in consumer surplus	232312	232312	232312	232312	232312	0	113747
55		Change in government revenue	155286	155286	155286	179894	229629	236977	160895
56		Net social gain	-6077	-56510	-174187	902	988	283213	54530
57									
58									
59		Potential level as % of actual							
60		Production	1.17	1.43	2.02	1.43	2.02	1.24	1.17
61		Consumption	0.74	0.74	0.74	0.74	0.74	0.63	0.90
62		Exports	2.05	2.84	4.67	2.84	4.67	2.51	1.39
63									
64		Welfare change as % of change in producer surplus							
65		Taxation only	.158	.247	.395	.247	.395		.098
66		Overall	.015	.127	.310	-.002	-.002		-.248
67									

Exercise 8

Exchange Rate and Trade Policies in Pakistan

1. Comment on the respective use of exchange rate and trade policies during these three periods. What are their combined effects on the incentives to imports and to exports? How has the trade policy bias between imports and exports evolved over time?

Figures 8M.1 and 8M.2 show contrasted periods. From 1960 to 1971, Pakistan maintained a constant nominal exchange rate and used trade taxes to affect effective exchange rates and control its balance of payments. Exports were subsidized at an approximate rate of 65% until 1968 and then increased to 100% in 1971. Imports were taxed; hence, import substitute sectors were protected at even higher rates of 135% to 200%. In relative terms, however, the implied incentive system favored import substitution, as the export sector was less protected than the import substitute sector. In 1972, a drastic devaluation of the currency by almost 100% reestablished a more rational exchange rate system. It brought the official exchange rate in line with the effective rate applying to exports. As the devaluation was accompanied by a corresponding decrease in import tariffs and export subsidy rates, the devaluation did not really change the terms of exchange for either sector. This shows the full equivalence between uniform trade taxes and exchange rate management. The exchange rate was then maintained constant over eight years, but annual devaluations have occurred since 1981. From 1973 to 1987, trade taxes were essentially used to protect the import substitute sectors and only marginally in 1976–78 to support exports. The differential protection of importables has been maintained roughly constant throughout the period. The change of regime in 1973 gave rise to a short period of perturbations. In the last few years, exports were traded at the official rate while imports were protected by a 50% tariff rate.

2. Comment on the evolution of real incentives to exports and imports as measured by the effective real exchange rate for exports and imports.

The graph of the real exchange rate (Figure 8M.2) shows a regular appreciation of the exchange rate between 1960 and 1972, when the nominal exchange rate was maintained constant despite inflation. Increasing import tariffs, however, maintained incentives for import substitutes. The graph also shows that the readjustment of 1973 surpassed the distortion that had been created over the previous 13 years. The 1974 and 1975 decrease in protection has been greatly amplified by an appreciation of the exchange rate due to domestic inflation, leaving imports and exports in a situation that was less favorable than in 1960. Only since 1983 have the devaluations overcompensated for differential inflation and the incentives for tradables been improved.

3. Report the three series of equilibrium exchange rates on the same graph and compare them. Describe the different concepts of equilibrium underlying these measures and explain why these measures differ so widely over the last seven years.

Equilibrium exchange rates are reported in Table 8M.1 and Figure 8M.3. The graph of the PPP equilibrium exchange rate [e*(PPP)] shows that, to keep up with the differential inflation between Pakistan and the rest of the world, the exchange rate should have been devalued regularly over the whole period, except in 1978–80 and 1986–87, when domestic inflation was lower than foreign price increases. (Note that the 1986–87 world price increase comes from the very strong appreciation of the yen.) The concept underlying the equilibrium exchange rate computed by the elasticity approach is different. It gives the exchange rate that should prevail to maintain the same balance-of-payments equilibrium if all trade taxes were removed. Therefore, it is a correction of the nominal exchange rate for trade taxes. Not surprisingly, it is much higher than the nominal exchange rate throughout the 1960–72 period, when trade taxes maintained an effective exchange rate above the nominal exchange rate. And, like the nominal exchange rate, it increases rapidly in the last period. The difference between $e1$* and $e2$* corresponds to a balance-of-payments deficit in 1960–71 and 1974–78, and to a surplus in 1983–87.

4. Estimate the real exchange equation and discuss the policy implications of the results.

Private transfers and foreign aid are measured in million dollars, while government expenditures are in million rupees. Thus, the first two variables must be deflated by the world price and the third by the domestic price in order to obtain real values. All three variables are then normalized over the years by dividing them by real GDP in 1985 prices. The resulting variables to be used in the regression are given in Table 8M.2. The regression results are:

$$\ln RER_E = 1.52 + 0.42 \ln \frac{1-t_E}{1+t_M} + 0.20 \ln p_E^w / p_M^w - 0.09 \ln RRemit - 0.10 \ln RAid + 0.85 \ln RGovt$$

(8.2) (2.8) (1.7) (-4.5) (-3.3) (7.1)

$R^2 = 0.89$, adjusted $R^2 = 0.83$.

The parameter ω is estimated to be 0.42, indicating that the export and import sectors bear 42% and 58% of the trade interventions, respectively. This means, for example, that when the export price is increased by 10% through subsidies ($1 - t_E$ increases by 10%), other domestic prices increase. This leaves the real incentive effect (RER_E) at only 4.2%, while the importables are penalized, since their price is now 5.8% lower than the domestic price index. In other words, more than half of the intended support to the export sector is converted into a taxation of the import substitute sector. Symmetrically, when import tariffs are introduced to raise the domestic price of imports by 10% ($(1-t_E)/(1+t_M)$ decreases by 10%), prices of nontradables increase and the export sector is penalized, as its price is now 4.2% below the domestic price index, while the real incentive effect on importables is only 5.8%. The parameter of transmission of international price to domestic relative price is 0.19, a low level indicating that an increase of 10% of the world price of the export commodities corresponds to a 1.9% relative price increase of the export price relative to the domestic price. The negative signs for the parameters of *RRemit* and *RAid* indicate that a transfer of foreign exchange through remittances or aid induce domestic inflation and a fall in the real exchange rate, as expected. On the other hand, the positive sign of *RGovt* contradicts the theory which says that government expenditures should induce increased inflation and thus a fall in the real exchange rate.

5. Calculate the time series of equilibrium exchange rates from 1973 to 1987 and report it on a graph. Compare this estimation of the equilibrium exchange rates with the other series.

The concept of the equilibrium exchange rate computed on the basis of the ω approach is similar to that used in the elasticity approach. Both correct the nominal exchange rate for the elimination of trade taxes. The method of calculation is different because it relies on the estimation of an equilibrium price for the nontradables. These two estimates give, however, similar estimation for the 1972–87 period over which estimation of the ω factor has been done.

The main weakness of the PPP approach is that it fails to take into account the changing conditions of external trade that justify changes in the exchange rate beyond differential inflation. For example, it was the necessity to reduce the balance-of-payments deficit of 1975–76 that forced Pakistan to impose tariffs on imports and subsidies on exports and that, equivalently, implies that the equilibrium exchange rate should have been devalued. Again, in 1983–87, an increase of the equilibrium exchange rate beyond inflation was necessitated by the need to reduce the balance-of-payment deficit and even to generate a surplus. On the other hand, you can now testify that calculation of the PPP equilibrium exchange rate is much easier and less demanding in terms of data. Thus, whenever conditions do not dramatically change, and inflation is the main culprit in the loss of competitiveness, it remains a useful indicator.

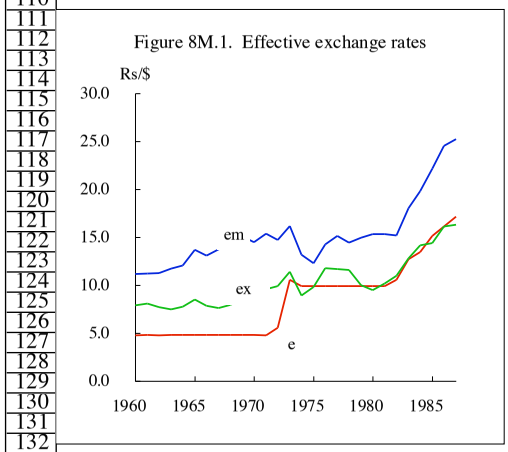


Figure 8M.1. Effective exchange rates
Rs/$
30.0
25.0
20.0
15.0
10.0
5.0
0.0
em
ex
e
1960
1965
1970
1975
1980
1985

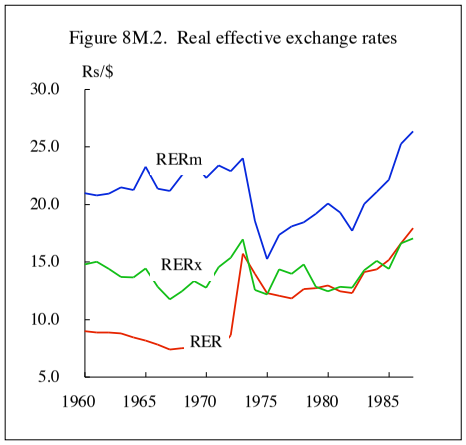


Figure 8M.2. Real effective exchange rates
Rs/$
30.0
25.0
20.0
15.0
10.0
5.0
RERm
RERx
RER
1960
1965
1970
1975
1980
1985

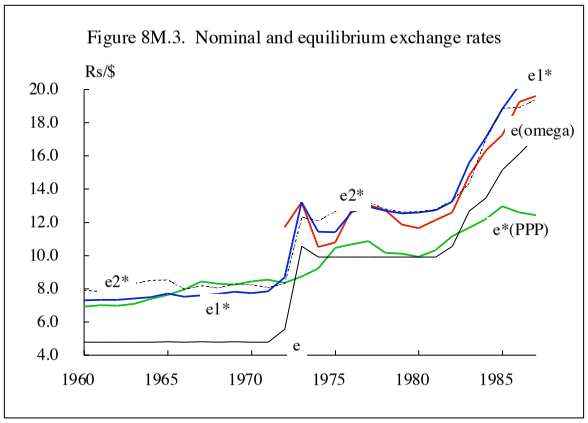


Figure 8M.3. Nominal and equilibrium exchange rates
Rs/$
20.0
18.0
16.0
14.0
12.0
10.0
8.0
6.0
4.0
e1*
e(omega)
e2*
e*(PPP)
e2*
e1*
e
1960
1965
1970
1975
1980
1985

Table 8M.1. Exchange rate and trade policies in Pakistan: Equilibrium exchange rates

		Effective exchange rates			Real exchange rates				Balance of current acc. deficit	Change BoT def. if T = 0	Equilibrium exchange rates			
		ex	em		Aggregate WPI	RER	RERx	RERm	(mn Rs)	(mn Rs)	e* (PPP)	e1* (elasticity)	e2*	e3* (omega)
1960		7.89	11.19		30.00	9.0	14.8	21.0	956	3979	6.9	7.3	7.9	
1961		8.10	11.21		30.01	8.9	15.0	20.8	781	3856	7.0	7.3	7.8	
1962		7.73	11.26		29.94	8.9	14.4	20.9	1304	4406	7.0	7.3	8.1	
1963		7.47	11.74		30.03	8.8	13.7	21.5	1863	5267	7.1	7.4	8.3	
1964		7.76	12.07		30.10	8.4	13.7	21.2	2283	5988	7.4	7.5	8.5	
1965		8.50	13.68		30.60	8.2	14.4	23.3	2018	6981	7.6	7.7	8.5	
1966		7.86	13.08		31.50	7.8	12.8	21.3	1028	6057	7.9	7.5	8.0	
1967		7.63	13.73		31.72	7.4	11.8	21.1	1507	7350	8.4	7.6	8.2	
1968		7.95	14.42		32.36	7.5	12.4	22.5	622	4651	8.3	7.7	8.1	
1969		8.50	15.07		33.47	7.5	13.4	23.7	748	4725	8.2	7.8	8.3	
1970		8.29	14.47		34.65	7.4	12.8	22.3	895	5046	8.4	7.7	8.2	
1971		9.56	15.39		35.70	7.3	14.5	23.4	410	5175	8.5	7.8	8.1	
1972		9.90	14.73		38.49	8.6	15.4	22.9	-1020	9346	8.4	8.7	8.3	11.7
1973		11.40	16.16		45.35	15.7	17.0	24.0	-2293	6797	8.7	13.2	12.3	13.2
1974		8.91	13.17		54.39	13.9	12.6	18.6	2854	6511	9.2	11.4	12.1	10.5
1975		9.80	12.28		57.99	12.3	12.2	15.2	6370	7446	10.4	11.4	12.7	10.8
1976		11.78	14.26		60.84	12.0	14.3	17.3	3912	13914	10.7	12.6	13.4	12.8
1977		11.68	15.15		65.78	11.8	13.9	18.1	1598	17117	10.9	12.9	13.2	13.0
1978		11.58	14.45		74.49	12.6	14.8	18.4	850	20719	10.2	12.7	12.8	12.7
1979		10.00	14.95		81.27	12.7	12.8	19.2	730	24997	10.1	12.5	12.6	11.8
1980		9.50	15.35		92.69	13.0	12.4	20.1	492	33249	9.9	12.6	12.6	11.6
1981		10.20	15.35		99.57	12.4	12.8	19.3	644	36962	10.3	12.7	12.8	12.1
1982		10.97	15.19		97.62	12.3	12.8	17.7	1357	37203	11.1	13.2	13.3	12.6
1983		12.83	18.03		99.22	14.1	14.3	20.0	-16098	38137	11.7	15.6	14.4	14.8
1984		14.15	19.82		100.81	14.3	15.1	21.1	-731	49623	12.2	17.1	17.0	16.3
1985		14.40	22.13		100.00	15.2	14.4	22.1	927	51678	13.0	18.8	18.9	17.3
1986		16.13	24.52		106.57	16.6	16.6	25.2	-17950	55797	12.6	20.2	18.9	19.2
1987		16.31	25.24		113.08	17.9	17.0	26.3	-21957	55343	12.4	20.9	19.4	19.6

Table 8M.2. Exchange rate and trade policies in Pakistan: Omega approach

	RRemit = R/Pw/ GDP	RAid = Aid/Pw/ GDP	RGovt = G/CPI/ GDP	ln RERx	ln RRemit	ln RAid	ln RGovt	ln (1-tx)/ (1+tm)	ln Pxw/ Pmw
1972	.015	.005	1.63	2.73	-4.17	-5.23	.49	-.40	.19
1973	.014	.004	1.57	2.83	-4.27	-5.50	.45	-.35	.40
1974	.013	.028	1.53	2.53	-4.32	-3.56	.43	-.39	.12
1975	.018	.029	1.63	2.50	-3.99	-3.53	.49	-.23	-.13
1976	.026	.031	1.67	2.66	-3.63	-3.49	.51	-.19	.00
1977	.048	.010	1.60	2.64	-3.03	-4.65	.47	-.26	.15
1978	.063	.006	1.75	2.69	-2.76	-5.13	.56	-.22	.23
1979	.061	.019	1.81	2.55	-2.79	-3.98	.59	-.40	.25
1980	.070	.011	1.69	2.52	-2.66	-4.47	.52	-.48	.10
1981	.060	.012	1.84	2.55	-2.81	-4.43	.61	-.41	-.01
1982	.073	.011	1.69	2.55	-2.62	-4.50	.52	-.33	-.04
1983	.075	.013	1.89	2.66	-2.59	-4.34	.64	-.34	.03
1984	.067	.012	1.99	2.71	-2.71	-4.40	.69	-.34	.04
1985	.057	.014	1.98	2.67	-2.86	-4.28	.68	-.43	.00
1986	.050	.016	2.33	2.81	-2.99	-4.14	.85	-.42	.24
1987	.041	.012	2.22	2.83	-3.20	-4.46	.80	-.44	.14

Regression results

	Px/Pm	Tx/Tm	Rgov	RAid	RRemit	Constant
Coefficient	.196	.421	.849	-.098	-.093	1.555
Standard deviation	.12	.15	.12	.03	.02	.19
R2; se(y)	.89	.04	#N/A	#N/A	#N/A	#N/A
F; df	16.8	10	#N/A	#N/A	#N/A	#N/A

Exercise 9

Relationship between Farm Size and Productivity: The Economics of Land Reform

1. Analyze the variations in factor use by farm size.

In Table 9M.1, the factor ratios show labor productivity to increase with farm size (from 334 to 733 U.S.$/man-year), while output per unit of capital follows no trend, and land productivity substantially decreases with farm size (from 1.6 to 0.15 with a quality adjusted measure of land). This reveals a contrast between intensive farming in small farms and extensive farming in larger farms.

2. Compare the performance of the different farm sizes under market and social prices.

At market prices, that is, with expensive labor and highly subsidized credit, large farms, which probably acquire their inputs at these prices, are more efficient than small farms. When the shadow price of labor is zero (Case II), the smallest farms are the most productive. But when the shadow price of labor is 171 (Case III), farms in the 50–100 ha range are the most productive. Small farms use more labor and large farms more capital than efficient use would command.

3. Compare the performance of the different farm sizes under effective prices and effective social prices.

In Case IV, the effective labor and capital costs probably incurred by the farms are computed. This is done by allowing for different prices for own and hired labor, for supervision costs, and for the differential costs of credit by farm size. Total factor productivity thus calculated represents the effective profitability of operation, given the structural characteristics of the costs and price distortions. The results show that only the large farms obtain a level of total factor productivity above 1.0, and that the medium farms are the least profitable. In Case V, when market distortions are removed but structural features are unchanged, the results are reversed. The productive advantage of the large farms disappears, which suggests that large farms enjoy a comparative advantage based not on effective costs, but on market distortions. With these true social costs, the medium farms are revealed as the most productive.

4. Compare the potential efficiency gains of each of the land reform programs. What are the efficiency costs of a welfare-oriented land reform?

The "efficiency oriented" land reform increases efficiency in all cases except under the actual effective prices. This suggests that land reform seems to have lost any economic rationale due to the high price distortions and, in particular, the heavily subsidized credit which artificially lowers the cost of capital. But, under the nondistorted prices, important efficiency gains could be achieved (efficiency increases by 37%, from 0.548 to 0.750). It is also interesting to

note that even the "welfare oriented" land reform would increase *TFP* under these social prices (efficiency increases by 28%). Comparing these two results, one can measure the efficiency cost of the welfare-oriented land reform as a potential loss of 9% of *TFP*.

5. Compare the efficiency gains of land reform after a drastic readjustment of the exchange rate with what you found in question 4.

Results are reported in Table 9M.2. The same calculations done under the new price regime show the distortionary factors which favor large farms to be even stronger (Case IV). When distortions are removed (Case V), the gain from land reform is even larger, with a 39% (31%) efficiency gain with the efficiency (welfare) oriented land reforms.

Table 9M.1. Relationship between farm size and productivity: Answers to questions 1 to 4

Farm group	Farm size	Number of farms N	Average farm size A	Average land value pA.A	Avg. gross receipts pQ	Labor input L	Capital pK.K	Factor ratios pQ/L	pQ/pK.K	pQ/A	pQ/pA.A	Land value pA
		(percent)	(ha)	(U.S.$)	(U.S.$)	(man-years)	(U.S.$)					
1	0-10 ha	47.8	3.7	189	318	.951	1495	334	.21	85.9	1.683	51.1
2	10-50 ha	32.9	25.5	763	782	1.734	3669	451	.21	30.7	1.025	29.9
3	50-100 ha	7.8	71.9	2452	1165	2.229	4156	523	.28	16.2	.475	34.1
4	100-200 ha	4.6	138.9	4247	1223	2.222	6139	550	.20	8.8	.288	30.6
5	200-500 ha	3.4	313.2	11112	1565	2.506	9396	625	.17	5.0	.141	35.5
6	> 500 ha	3.5	1178.0	17119	2589	3.534	11662	733	.22	2.2	.151	14.5

Total factor productivity at constant prices (market or social prices)

	Market prices I
Wage	342
Interest rate	0.03

		Actual land distribution TFP	Total area	NA.TFP	Redistribution Efficiency (percent land)	Welfare
Group	1	0.846	177	150		50
	2	1.077	839	904		50
	3	1.213	561	680	100	
	4	1.141	639	729		
	5	1.063	1065	1132		
	6	1.249	4123	5152		
			7403	8746		
Average TFP				1.181	1.213	0.962

Total factor productivity with transactions costs (effective and social prices)

		Effective prices IV
Wage	wf	0
	wnf	342
Supervision	s	0.2
Family labor	Lf	1.7
Interest rate	is	0.25
	il	0.03

		Labor costs	Interest rate	Capital costs	TFP	Actual land distribution Total area	NA.TFP	Redistribution Efficiency (percent land)	Welfare
	1	0	.25	417	.763	177	134.9		50
	2	12	.24	1066	.726	839	609.0		50
	3	200	.22	1448	.707	561	396.4	100	
	4	197	.20	2042	.546	639	348.9		
	5	320	.11	2262	.606	1065	645.4		
	6	857	.03	1001	1.393	4123	5743.3		
						7403	7878.0		
Average TFP							1.064	.707	.744

Table 9M.1. Relationship between farm size and productivity: Answers to questions 1 to 4 (continued)

Prices		Market prices I	Social prices II	Social prices III	Effective prices IV	Effective social prices V
	Wages	342	0	171	0	171
					342	171
	Supervision				0.2	0.2
	Family labor				1.7	1.7
	Interest	.03	.15	.15	.25	.18
					.03	.15
TFP	1	.846	1.259	.766	.763	.684
	2	1.077	1.176	.813	.726	.718
	3	1.213	1.175	.849	.707	.750
	4	1.141	.785	.631	.546	.560
	5	1.063	.509	.447	.606	.417
	6	1.249	.600	.526	1.393	.512
Average TFP						
	Actual distribution	1.181	.727	.586	1.064	.548
	Efficiency land reform	1.213	1.175	.849	.707	.750
	Welfare land reform	.962	1.218	.790	.744	.701

Table 9M.2. Relationship between farm size and productivity: Answers to question 5

Farm group	Farm size	Number of farms N	Average farm size A	Average land value pA.A	Avg. gross receipts pQ	Labor input L	Capital pK.K	Factor ratios pQ/L	pQ/pK.K	pQ/A	pQ/pA.A	Land value pA
		(percent)	(ha)	(U.S.$)	(U.S.$)	(man-years)	(U.S.$)					
1	0-10 ha	47.8	3.7	189	382	.951	1495	401	.26	103.1	2.02	51.1
2	10-50 ha	32.9	25.5	763	938	1.734	3669	541	.26	36.8	1.23	29.9
3	50-100 ha	7.8	71.9	2452	1398	2.229	4156	627	.34	19.4	.57	34.1
4	100-200 ha	4.6	138.9	4247	1468	2.222	6139	660	.24	10.6	.35	30.6
5	200-500 ha	3.4	313.2	11112	1878	2.506	9396	750	.20	6.0	.17	35.5
6	> 500 ha	3.5	1178.0	17119	3107	3.534	11662	879	.27	2.6	.18	14.5

Total factor productivity at constant prices (market or social prices)

	Market prices I
Wage	342
Interest rate	.036

		Actual land distribution TFP	Total area	NA.TFP	Redistribution Efficiency (percent land)	Welfare (percent land)
Group	1	0.989	177	175		50
	2	1.247	839	1046		50
	3	1.398	561	784	100	
	4	1.294	639	827		
	5	1.177	1065	1254		
	6	1.384	4123	5706		
			7403	9792		
Average TFP				1.323	1.398	1.118

Total factor productivity with transactions costs (effective and social prices)

		Effective prices IV
Wage	wf	0
	wnf	342
Supervision	s	0.2
Family labor	Lf	1.7
Interest rate	is	.300
	il	.036

		Labor costs	Interest rate	Capital costs	TFP	Actual land distribution Total area	NA.TFP	Redistribution Efficiency (percent land)	Welfare (percent land)
	1	0	.30	500	.763	177	134.9		50
	2	12	.29	1279	.727	839	610.1		50
	3	200	.26	1738	.721	561	404.6	100	
	4	197	.24	2450	.554	639	354.1		
	5	320	.13	2715	.619	1065	659.0		
	6	857	.04	1202	1.509	4123	6221.6		
						7403	8384.4		
Average TFP							1.132	.721	.745

Table 9M.2. Relationship between farm size and productivity: Answers to question 5 (continued)

Prices		Market prices I	Social prices II	Social prices III	Effective prices IV	Effective social prices V
Wages		342	0	171	0	171
					342	171
Supervision					0.2	0.2
Family labor					1.7	1.7
Interest		.036	.180	.180	.300	.216
					.036	.180
TFP	1	.989	1.259	.819	.763	.726
	2	1.247	1.176	.857	.727	.753
	3	1.398	1.175	.890	.721	.783
	4	1.294	.785	.652	.554	.577
	5	1.177	.509	.456	.619	.426
	6	1.384	.600	.537	1.509	.525
Average TFP						
Actual distribution		1.323	.727	.605	1.132	.565
Efficiency land reform		1.398	1.175	.890	.721	.783
Welfare land reform		1.118	1.218	.838	.745	.739

Exercise 10

Input-Output and Social Accounting Matrix Multipliers in Morocco

1. Describe main characteristics of the economy based on the SAM.

Domestic production is best measured by value added (at producer price) by sector, which is computed as the sum of the payments to the factors of production and to the households and firms. This shows that tertiary sectors account for more than half of domestic activities, with 40.1% of value added in the service sector and 14.2% in the government sector. Industry accounts for 24.4% and agriculture for 21.3%. Note the importance of phosphates, which produce 3.9% of total value added. The economy is very open to foreign trade, with exports and imports representing 21% and 31% of GDP. Imports are heavily concentrated in the sector of production goods, followed by consumption goods, refined oil, and cereals. The structure of exports shows Morocco heavily dependent on phosphates for its foreign exchange, with some level of diversification between industry and agriculture. Factor shares show phosphates to distribute very little income to labor in contrast to the other industrial sectors. The value added of refined oil may be misleading, as it is a public sector which contributes to the government resources, here confounded with taxes in the government row. Textiles and leather and construction services have higher shares of labor income for unskilled labor than the other sectors. Agricultural production shows an interesting contrast, with a higher concentration of agricultural exports in the larger farms and a higher concentration of livestock production among the rural poor. The government sector is large, with 14% of GDP. The disaggregation of this SAM is not sufficient to analyze the structure of its income. Note that mills are subsidized. Finally, remittances account for 4470 million DH or 24% of foreign exchange earnings (computed as 23757 minus the deficit 5484), and the balance-of-payment deficit is equal to 8.6% of GDP (see Table 10M.1).

2. Compute the input-output multipliers. What is the impact of an increase in the exports of Ag. exp. on its production and that of other sectors, and on total production? Which sector has the highest multiplier on itself? The highest total multiplier? The highest linkage on the rest of the economy?

Input-output multipliers are given in Table 10M.2. The sectors that have the highest multiplier on themselves are production goods and services. Highest total production multipliers are in mills and textiles and leather. These sectors also have the highest linkages with the rest of the economy. Agriculture and mining have the lowest production multipliers because of their low intermediate demand.

3. SAM multipliers: What is the impact of an Ag. exp. exports increase on production of Ag. exp. and other sectors, on total production, and on household income? Compare with the input-output multipliers.

SAM multipliers are given in Table 10M.3. They are larger than input-output multipliers. An increase in exogenous demand of 1 million DH of Ag. exp. will induce a production of 1.11

million DH in this sector, of almost 1 million DH in the service (trade) sector, and of 1.72 million DH in the other sectors of the economy. It would generate an increase of 1.45 million DH in household incomes, relatively equally distributed among household classes other than the highest urban group. The generation of income for urban groups is due to the induced increase in production in all other sectors. Note that the highest income urban group does not benefit from such demand-induced growth; its income depends heavily on high-skill wages and is concentrated in the administrative sector.

Which sectors have the highest total production multipliers, the highest impact on income? Compare the linkage on the rest of the economy with the input-output analysis.

The sectors with the highest production multipliers are still mills and textiles, closely followed by agriculture. The sectors with the highest multiplier on household income are Ag. exp., other agriculture, mills, and the administrative sector. The difference between input-output and SAM multipliers is mainly due to the importance of the linkage on the rest of the economy in the SAM analysis, compared with its equivalent in the input-output analysis.

What is the impact of a transfer to the rural poor households on their and the other households' income? Compare these income effects across groups.

It is the poorest rural and urban poorest which have the highest production and income multipliers. A transfer of 1 million DH to the rural poor induces a 1.18 increase in income, with a high spillover (0.80 million DH) on the other households' income. By contrast, a 1 million DH transfer to the urban rich only induces a 1.03 and 0.63 million increase in their and other households' incomes, respectively. This is because rich households save more and consume more of the commodities with a high import content.

4. Policy simulations with the SAM.

Results of five policy experiments are given in Table 10M.4.

Experiment A. Cereal price support policy. What is the impact on production and income?

This experiment does not simulate a supply response effect of the type that was analyzed in Chapters 3 and 4, where profit-maximizing producers responded to relative prices in their production decisions. In this SAM context, the experiment simulates the income effect of a price support, with its consequences on demand and its multiplier effect. The transfer of income to rural households induces increased demand in proportion to their consumption structure. The overall impact on production is a 0.17% growth. Households' income increase is 187.9 million DH, or almost double the initial transfer. Rural high-income households do not gain much more than the transfer they receive, while rural low-income and urban households benefit greatly from the multiplier effect of this policy on the economy.

Experiment B. What is the impact of an increase of exports on production and income? What is the net change in the balance of trade?

This policy has a stronger effect on production, but a smaller effect on income. This is because its first impact is a demand for commodities, which directly induces an increase in production. Then, as leakages through imports and taxes operate, the income distributed to

households, in this first-round effect, is already substantially lower than 100 million DH. This contrasts with experiment A where the first-round effect was a transfer of the full 100 million DH to households, while leakages from taxes and savings reduce the amount demanded to sectors to less than 100 millions DH. Note that the initial increase of 100 million DH in exports induces additional imports of 40 million DH and, hence, a decrease in the balance-of-trade deficit of 60 million DH.

Experiment C and D. Compare the impact of income transfers to urban rich and poor households.

Note that, despite the fact that the urban poor saves less than the urban rich, there is little difference in total savings. Transfer to the poor generates a higher growth and, hence, income to the firms, which are important contributors to total savings.

Comparing simulations A to D (which assume an initial injection of 100 million DH in the economy) shows that production is best stimulated by an increase in exports. Total income is best stimulated by a direct transfer of income to the urban low-income group; followed by a cereal price support which induces a far more egalitarian distribution of income.

Experiment E. Income redistribution of 100 million DH: Impact on growth and savings? Comment on the implied short-run/long-run trade-off.

This simulation shows that with no external injection, redistribution of income alone can generate some growth in production and income (72% and 24% of the amount of the redistribution, respectively), but at the cost of a decline in savings. This illustrates a trade-off between short-term growth and savings for potential long-term growth. Although it contributes to a deterioration of the balance of trade, the increase in imports should not be of great concern as it is lower than the increase in domestic production.

Table 10M.1. Structure of the economy

	VA		Exports		Imports		Labor/ VA	Unskilled/ all labor
	DH	%	DH	%	DH	%	(%)	(%)
Cereals	4606	7.2	114	0.9	1352	6.8		
Ag. exports	3284	5.1	1606	12.2	54	0.3		
Other ag.	5743	9.0	193	1.5	503	2.5		
Phosphates	2483	3.9	3613	27.4	26	0.1	18.1	60.9
Refined oil	315	0.5	474	3.6	3916	19.7	39.3	73.3
Mills, bakery	1554	2.4	59	0.4	638	3.2	23.5	73.9
Textiles, leather	1409	2.2	1176	8.9	32	0.2	26.4	85.7
Cons. goods	4283	6.7	2217	16.8	2694	13.6	30.9	71.1
Prod. goods	5419	8.5	1448	11.0	9243	46.5	33.3	56.6
Const. services	25597	40.1	2283	17.3	1418	7.1	30.3	81.7
Administration	9085	14.2					96.5	63.6
Total	63779		13183		19875			

	A	B	C	D	E	F	G	H	I	J	K	L	M
104	**Table 10M.2. Input-output and social accounting matrix multipliers in Morocco: Production multipliers**												
105													
106													
107					Other		Refined	Mills,	Textiles,	Cons.	Prod.	Constr.,	
108			Cereals	Ag. exp	ag.	Phosph.	oil	bakery	leather	goods	goods	serv.	Admin.
109			1	2	3	4	5	6	7	8	9	10	11
110													
111	1	Cereals	1.10	.00	.12	.00	.00	.61	.02	.06	.00	.01	.01
112	2	Ag. exp.	.00	1.01	.00	.00	.00	.01	.01	.02	.00	.00	.00
113	3	Other ag.	.00	.01	1.07	.01	.00	.05	.07	.21	.01	.01	.01
114	4	Phosphates	.00	.00	.00	1.01	.00	.00	.00	.00	.03	.01	.01
115	5	Refined oil	.03	.05	.03	.07	1.10	.06	.03	.03	.06	.06	.06
116	6	Mills, bakery	.00	.00	.02	.00	.00	1.26	.01	.01	.00	.01	.00
117	7	Text., leather	.00	.00	.00	.00	.00	.00	1.10	.00	.00	.00	.01
118	8	Cons. goods	.02	.03	.07	.02	.01	.05	.42	1.26	.03	.07	.04
119	9	Prod. goods	.10	.17	.06	.16	.08	.12	.17	.16	1.31	.23	.28
120	10	Const., serv.	.20	.43	.20	.18	.17	.24	.53	.31	.25	1.27	.22
121	11	Administration	.00	.00	.00	.00	.00	.00	.00	.00	.00	.01	1.00
122													
123	Total production		1.45	1.71	1.58	1.46	1.36	2.42	2.38	2.08	1.69	1.69	1.63
124	Own multiplier		1.10	1.01	1.07	1.01	1.10	1.26	1.10	1.26	1.31	1.27	1.00
125	Linkage oth. sectors		.35	.70	.51	.45	.27	1.16	1.28	.82	.38	.41	.63

Table 10M.3. Input-output and social accounting matrix multipliers in Morocco: SAM multipliers

		Cereals	Ag. exp	Other ag.	Phosph.	Refined oil	Mills, bakery	Textiles, leather	Cons. goods	Prod. goods	Constr., serv.	Admin.	Ag. workers	Nonag. skilled	Nonag. unsk.	Inf. capital	Formal capital	Rural l. inc.	Rural m. inc.	Rural h. inc.	Urban l. inc.	Urban m. inc.	Urban h. inc.	Firms
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
1	Cereals	1.30	.24	.39	.11	.03	.82	.19	.20	.07	.17	.20	.39	.17	.29	.22	.11	.41	.34	.27	.29	.18	.14	.11
2	Ag. exp.	.09	1.11	.12	.05	.02	.11	.09	.08	.04	.08	.10	.16	.09	.15	.11	.05	.17	.13	.10	.15	.09	.07	.05
3	Other ag.	.14	.16	1.25	.10	.03	.21	.21	.32	.07	.15	.18	.23	.17	.24	.20	.09	.24	.21	.17	.24	.18	.16	.08
4	Phosphates	.01	.01	.01	1.01	.00	.01	.01	.01	.03	.01	.01	.01	.01	.01	.01	.00	.01	.01	.01	.01	.01	.01	.00
5	Refined oil	.10	.15	.12	.13	1.11	.15	.12	.10	.10	.15	.17	.10	.14	.15	.14	.06	.10	.11	.10	.15	.14	.15	.05
6	Mills, bakery	.12	.15	.17	.07	.02	1.39	.11	.10	.05	.11	.13	.19	.12	.19	.15	.07	.19	.21	.19	.19	.13	.10	.06
7	Text., leather	.08	.09	.10	.05	.01	.09	1.18	.06	.03	.07	.10	.13	.10	.13	.11	.05	.13	.13	.11	.13	.10	.10	.05
8	Cons. goods	.37	.45	.52	.26	.08	.47	.79	1.55	.19	.42	.50	.58	.48	.64	.54	.24	.58	.57	.50	.65	.48	.48	.22
9	Prod. goods	.35	.47	.37	.33	.13	.43	.45	.37	1.43	.49	.62	.40	.36	.47	.40	.18	.40	.40	.36	.47	.36	.36	.16
10	Const., serv.	.66	.99	.77	.50	.26	.80	1.03	.69	.47	1.75	.83	.74	.67	.85	.73	.32	.75	.72	.65	.86	.66	.67	.29
11	Administration	.01	.01	.01	.00	.00	.01	.01	.01	.00	.01	1.01	.01	.01	.01	.01	.00	.01	.01	.01	.01	.01	.01	.00
12	Ag. workers	.09	.11	.09	.02	.00	.07	.03	.03	.01	.02	.03	1.05	.03	.04	.03	.01	.05	.04	.03	.04	.03	.02	.01
13	Nonag. skilled	.04	.05	.05	.07	.02	.07	.07	.06	.06	.08	.28	.05	1.04	.05	.05	.02	.05	.05	.04	.05	.04	.04	.02
14	Nonag. unsk.	.13	.18	.15	.16	.06	.21	.26	.17	.12	.28	.56	.15	.13	1.17	.15	.07	.15	.15	.14	.17	.13	.13	.06
15	Informal capital	.20	.29	.25	.15	.07	.43	.50	.27	.17	.44	.26	.25	.21	.28	1.24	.11	.26	.25	.23	.28	.22	.21	.10
16	Formal capital	.14	.20	.17	.52	.07	.23	.24	.21	.19	.30	.19	.17	.15	.20	.17	1.07	.17	.17	.15	.20	.15	.15	.07
17	Rural low inc.	.27	.23	.54	.10	.02	.23	.14	.17	.06	.11	.13	.90	.11	.17	.14	.13	1.18	.16	.12	.16	.12	.10	.13
18	Rural med. inc.	.31	.23	.29	.07	.02	.23	.09	.11	.04	.08	.09	.42	.08	.13	.10	.08	.15	1.13	.10	.13	.09	.07	.08
19	Rural high inc.	.20	.39	.16	.04	.01	.15	.07	.07	.03	.06	.07	.11	.06	.10	.08	.04	.12	.10	1.08	.10	.06	.05	.04
20	Urban low inc.	.23	.33	.27	.31	.10	.41	.49	.31	.22	.50	.70	.28	.25	1.31	.64	.27	.28	.28	.25	1.32	.25	.24	.28
21	Urban med. inc.	.16	.23	.20	.17	.06	.33	.37	.22	.16	.35	.39	.20	.94	.23	.81	.13	.20	.20	.18	.23	1.18	.17	.12
22	Urban high inc.	.03	.05	.04	.09	.02	.06	.06	.05	.04	.07	.10	.04	.27	.05	.06	.14	.04	.04	.04	.05	.04	1.03	.06
23	Firms	.17	.24	.20	.56	.09	.28	.29	.25	.22	.36	.26	.21	.23	.23	.24	1.01	.21	.20	.18	.23	.24	.18	1.08
	Total production	3.23	3.83	3.82	2.61	1.69	4.50	4.19	3.48	2.49	3.42	3.85	2.95	2.32	3.14	2.63	1.17	2.99	2.84	2.47	3.14	2.34	2.24	1.08
	Own multiplier	1.30	1.11	1.25	1.01	1.11	1.39	1.18	1.55	1.43	1.75	1.01												
	Linkage oth. sectors	1.92	2.72	2.57	1.59	.58	3.11	3.01	1.93	1.06	1.66	2.84												
	Induced hhold inc.	1.20	1.45	1.50	.77	.22	1.41	1.22	.94	.54	1.16	1.48	1.96	1.72	1.98	1.82	.79	1.98	1.90	1.77	1.98	1.73	1.66	.71

Table 10M.4. Input-output and social accounting matrix multipliers in Morocco: Policy simulations

	Base values	Simulation A			Simulation B			Simulation C			Simulation D			Simulation E		
	X	Shock ΔF	Impact ΔX	Change ΔX/X	Shock ΔF	Impact ΔX	Change ΔX/X	Shock ΔF	Impact ΔX	Change ΔX/X	Shock ΔF	Impact ΔX	Change ΔX/X	Shock ΔF	Impact ΔX	Change ΔX/X
	(million DH)	(million DH)		(%)	(million DH)		(%)	(million DH)		(%)	(million DH)		(%)	(million DH)		(%)
1 Cereals	9476	.0	33.7	.36	.9	16.8	.18	.0	29.2	.31	.0	14.1	.15	.0	13.2	.14
2 Ag. exp.	5897	.0	13.4	.23	12.2	19.2	.33	.0	14.9	.25	.0	7.4	.13	.0	5.7	.10
3 Other ag.	10103	.0	20.3	.20	1.5	17.3	.17	.0	24.2	.24	.0	15.7	.16	.0	6.5	.06
4 Phosphates	4411	.0	.9	.02	27.4	28.7	.65	.0	1.1	.02	.0	.8	.02	.0	.2	.00
5 Refined oil	7166	.0	10.5	.15	3.6	16.0	.22	.0	14.8	.21	.0	14.6	.20	.0	-.1	.00
6 Mills, bakery	5955	.0	19.6	.33	.4	9.9	.17	.0	18.8	.32	.0	9.7	.16	.0	5.4	.09
7 Textiles, leather	5313	.0	12.6	.24	8.9	16.0	.30	.0	13.2	.25	.0	9.7	.18	.0	3.3	.06
8 Cons. goods	24176	.0	55.1	.23	16.8	56.7	.23	.0	64.5	.27	.0	48.3	.20	.0	13.6	.06
9 Prod. goods	31876	.0	38.9	.12	11.0	50.7	.16	.0	47.2	.15	.0	35.9	.11	.0	8.6	.03
10 Const., services	48472	.0	70.9	.15	17.3	84.9	.18	.0	85.5	.18	.0	67.1	.14	.0	15.1	.03
11 Administration	13998	.0	.6	.00	.0	.7	.01	.0	.8	.01	.0	.6	.00	.0	.1	.00
12 Ag. workers	1499	.0	4.1	.27	.0	3.4	.22	.0	4.1	.27	.0	2.1	.14	.0	1.6	.10
13 Nonag. skilled	6134	.0	4.6	.07	.0	6.3	.10	.0	5.4	.09	.0	4.1	.07	.0	1.0	.02
14 Nonag. unskilled	14825	.0	14.7	.10	.0	18.6	.13	.0	17.4	.12	.0	13.3	.09	.0	3.3	.02
15 Informal capital	14455	.0	24.5	.17	.0	27.1	.19	.0	28.4	.20	.0	21.3	.15	.0	5.6	.04
16 Formal capital	12043	.0	16.5	.14	.0	30.2	.25	.0	19.6	.16	.0	15.0	.12	.0	3.6	.03
17 Rural low income	7501	25.2	40.5	.54	.0	13.4	.18	.0	16.5	.22	.0	9.9	.13	19.5	24.4	.33
18 Rural medium inc.	6172	44.8	57.4	.93	.0	10.0	.16	.0	12.5	.20	.0	6.9	.11	16.0	20.5	.33
19 Rural high income	4174	30.0	39.7	.95	.0	9.4	.22	.0	9.9	.24	.0	5.1	.12	-18.6	-14.7	-.35
20 Urban low income	24886	.0	27.0	.11	.0	34.2	.14	100.0	131.7	.53	.0	24.0	.10	64.5	69.9	.28
21 Urban medium inc.	14849	.0	19.5	.13	.0	23.1	.16	.0	22.7	.15	.0	17.0	.11	-66.1	-61.8	-.42
22 Urban high income	3457	.0	3.8	.11	.0	6.1	.18	.0	4.5	.13	100.0	103.4	2.99	-15.4	-14.7	-.43
23 Firms	15275	.0	19.8	.13	.0	34.6	.23	.0	23.5	.15	.0	17.9	.12	.0	.4	.00
Total production	166843	.0	276.6	.17	100.0	317.0	.19	.0	314.2	.19	.0	223.8	.13	.0	71.6	.04
Household income	61039	100.0	187.9	.31	.0	96.2	.16	100.0	197.8	.32	100.0	166.4	.27	.0	23.6	.04
Government income ΔG	14941		24.3	.16		32.4	.22		27.2	.18		28.3	.19		-2.4	-.02
Imports ΔI	23757		35.1	.15		40.0	.17		41.2	.17		39.5	.17		6.1	.03
Savings ΔS	17933		40.6	.23		27.5	.15		31.6	.18		32.1	.18		-3.7	-.02

Policy definitions:

A- Cereal price support of 100 million DH

B- Exports increase by 100 million DH

C- Income transfer of 100 million DH to urban poor households

D- Income transfer of 100 million DH to urban rich households

E- Income redistribution of 100 million DH

Exercise 11.1

A Multimarket for the Grain-Livestock Sector in North Africa

1. First experiment: Reduce the wheat producer price by 10% (that is, a 37% reduction in the subsidy, from 1300 to 820 DA/ton).

How does a change in the producer price of wheat affect the supply of barley and livestock? Why does the demand for wheat fall even though the consumer price of bread has not changed? How does the supply and price of livestock change and why?

Results are given in Table 11M.1. A decrease in the producer price of wheat induces a decrease in the production of this cereal (4%) and an increase in the production of the competitive cereal, barley (2.95%). With no other indirect effect, these two cereals markets would be simply rebalanced by changes in imports. But, as a further consequence of the price change, the production switch is also accompanied by a decrease in nominal income. Consumer demands for wheat and livestock thus decrease, following their respective income elasticities. In the wheat market, as production decreases more than demand, imports increase (3.56%). In the livestock market, the decline in demand induces a fall in price and production until supply equals demand. The result is a fall in price by 1.86% and a fall in both production and demand by 0.19%. Declines in livestock price and production, in turn, induce a reduction of barley demand (–.013%). In the barley market, the combination of production increase and demand reduction induces a large decrease in imports (–7.85%).

Contrast the observed changes in nominal as opposed to real income. How do you explain the difference?

The consumer price index decreases slightly (0.08%) as the price of livestock decreases. This partly compensates the decrease in nominal income, leaving a real income decrease of 0.45%.

What are the effects on the government budget?

The consequences for the government budget are: (1) The 10% decline in the wheat price and reduction in the subsidized quantity combine to induce a large reduction of the wheat producer subsidy (39.4%). (2) However, this is compensated by an increase in the barley subsidy corresponding to the increase in production. (3) On the demand side, the reduction in demand for barley and consumption of wheat induce a reduction in the consumer wheat subsidy and barley tax revenue. The net outcome is a 21.4% reduction of budgetary costs.

Finally, what is the impact on the balance of trade and why?

The policy has a negative effect on the balance of trade, since the increase in wheat imports is only partially compensated by the decline in barley imports.

2. Second experiment: Reduce barley producer price by 10% (that is, a 43% reduction in subsidy per ton).

The results are very similar, although as the barley production value is only 27% of wheat production value, the income effect and induced effects on the livestock sector are smaller.

3. Third experiment: Increase barley user price by 10% (that is, a 70% increase in the tax rate, from 500 to 850 DA/ton).

Increasing the price of barley, which is an input in livestock production, induces a reduction in livestock production (–0.29%) and demand for barley (–0.85%), and a loss in agricultural profit and income. The reduction in livestock production induces a price increase. For the consumers, the decrease in nominal income (–0.12%) and the change in relative prices (no change in wheat price and an increase in livestock price) induce a decrease in livestock demand (0.29%) and an increase in wheat demand (0.10%). As production of wheat and barley remains unchanged, the wheat and barley markets are balanced by increasing wheat imports and decreasing barley imports. The net effect is a slight decrease in the import bill.

The overall consumer price index increases, and real income decreases more than nominal income.

There is no change in producer subsidies and a very small change in consumer wheat subsidies due to increased consumption. As barley tax revenues constitute a relatively small part of the government budget, the large increase in barley user tax only induces a 6.7% reduction in net government costs.

4. Fourth experiment: Increase wheat consumer price by 10%.

This produces a large decrease in the consumption of wheat, and a small increase in the consumption of livestock. This increase in demand, in turn, induces a small increase in both the price and the production of livestock. Nominal income increases slightly, but real income falls.

The large reduction in the consumer wheat subsidy, added to some increase in the tax revenue from barley, induces a large reduction in net budgetary costs.

Comparison of these experiments shows the trade-offs between reduction of budgetary costs, balance of trade, and real income. The two policies that most reduce government budgetary costs (Experiments 4 and 1) are also the policies which most affect real income. And only an increase in wheat consumer price can substantially reduce the import bill.

5. Income Distribution Effects

Reduction of producer subsidies (Experiments 1 and 2) induces a decrease in rural incomes. Given the structure of incomes (reported in cells G116–K120 of Table 11M.2), reduction of the wheat subsidy has unequal effects across income groups, with rich households more affected than the others. By contrast, reduction of the barley subsidy has smaller and equal bearing on all three groups. A fall in the price index due to decline in the livestock price is small and regressive, as livestock is a luxury good more consumed by the rich. The net effect on real incomes is a positive impact on urban households and a negative impact on rural households, particularly on the richer group.

The increase in the barley user tax induces a reduction of rural profit, with a regressive effect, as livestock production represents a higher share of income for the poor. By contrast, the price impact is progressive, as the rich households consume more livestock.

The decrease in the wheat consumer subsidy has a strong regressive effect on the consumer price indexes, as the poor spend a higher share of their income on wheat. However, the induced

rise in the price of livestock mitigates the effects on the rural poor households, leaving them the least affected.

Table 11M.1. A multimarket for the grain-livestock sector in North Africa

Data on the agricultural sector

	Quantities (1000 tons)				Prices (DA/ton)			
Commodities	Supply	Derived demand	Final demand	Imports	Producer	User	Consumer	Border
Wheat (bread)	3000		6000	3000	4800		3000	3500
Barley	1000	1400		400	3900	3500		3000
Livestock	200		200	0	35000		65700	0

Income = 295000000 (thousand DA)

Elasticities	Producer and user price elasticities				Consumer price and income elasticities			
Production	Wheat	Barley producer	Livestock	Barley user	Consumption	Wheat	Livestock	Income
Wheat	.40	-.08	0	0	Wheat	-.50	.06	0.2
Barley supply	-.30	.50	0	0	Livestock	.05	-.10	0.7
Livestock	0	0	.10	-.05				
Barley demand	0	0	.07	-.10				

Multimarket model

A matrix	Equation	ΔSw	ΔSb	ΔSl	ΔDb	ΔDw	ΔPl	ΔMw	ΔMb	ΔDl	Δy
	(1)	1.00	0	0	0	0	0	0	0	0	0
	(2)	0	1.00	0	0	0	0	0	0	0	0
	(3)	0	0	1.00	0	0	-0.10	0	0	0	0
	(4)	0	0	0	1.00	0	-0.07	0	0	0	0
	(5)	0	0	0	0	1.00	-0.06	0	0	0	-0.20
	(6)	0	0	0	0	0	0.10	0	0	1.00	-0.70
	(7)	1.00	0	0	0	-2.00	0	1.00	0	0	0
	(8)	0	2.50	0	-3.50	0	0	0	1.00	0	0
	(9)	0	0	-1.00	0	0	0	0	0	1.00	0
	(10)	0	0	0	0	0	-0.02	0	0	0	1.00

B matrix		ΔPwp	ΔPbp	ΔPbu	ΔPwc
	(1)	.40	-.08	0	0
	(2)	-.30	.50	0	0
	(3)	0	0	-.05	0
	(4)	0	0	-.10	0
	(5)	0	0	0	-.50
	(6)	0	0	0	.05
	(7)	0	0	0	0
	(8)	0	0	0	0
	(9)	0	0	0	0
	(10)	.05	.01	-.02	0

A inverse	ΔSw	ΔSb	ΔSl	ΔDb	ΔDw	ΔPl	ΔMw	ΔMb	ΔDl	Δy
ΔSw	1.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
ΔSb	.00	1.00	.00	.00	.00	.00	.00	.00	.00	.00
ΔSl	.00	.00	.45	.00	.00	.55	.00	.00	-.55	.38
ΔDb	.00	.00	-.39	1.00	.00	.39	.00	.00	-.39	.27
ΔDw	.00	.00	-.35	.00	1.00	.35	.00	.00	-.35	.45
ΔPl	.00	.00	-5.45	.00	.00	5.45	.00	.00	-5.45	3.82
ΔMw	-1.00	.00	-.71	.00	2.00	.71	1.00	.00	-.71	.89
ΔMb	.00	-2.50	-1.36	3.50	.00	1.36	.00	1.00	-1.36	.95
ΔDl	.00	.00	.45	.00	.00	.55	.00	.00	.45	.38
Δy	.00	.00	-.13	.00	.00	.13	.00	.00	-.13	1.09

Table 11M.1 (continued)

A inverse*B		ΔPwp	ΔPbp	ΔPbu	ΔPwc
	ΔSw	.40	-.08	.00	.00
	ΔSb	-.30	.50	.00	.00
	ΔSl	.02	.01	-.03	.03
	ΔDb	.01	.00	-.09	.02
	ΔDw	.02	.01	.01	-.48
	ΔPl	.19	.05	.21	.28
	ΔMw	-.36	.09	.02	-.96
	ΔMb	.79	-1.24	-.30	.07
	ΔDl	.02	.01	-.03	.03
	Δy	.05	.01	-.01	.01

Policy instruments	Initial value	New value	% change Δp
ΔPwp	4800	4320	-10
ΔPbp	3900	3900	0
ΔPbu	3500	3500	0
ΔPwc	3000	3000	0

Results of price policy experiments: A inverse * B * Δp

	Initial value	Policy	Copy of policy results			
ΔPwp	4800	-10	-10	0	0	0
ΔPbp	3900	0	0	-10	0	0
ΔPbu	3500	0	0	0	10	0
ΔPwc	3000	0	0	0	0	10
Endogenous variables		(% change)	(% change over initial values)			
Sw	3000	-4.00	-4.00	.80	.00	.00
Sb	1000	2.95	2.95	-5.00	.00	.00
Sl	200	-.19	-.19	-.05	-.29	.28
Db	1400	-.13	-.13	-.04	-.85	.20
Dw	6000	-.22	-.22	-.06	.10	-4.82
Pl	35000	-1.86	-1.86	-.50	2.09	2.82
Mw	3000	3.56	3.56	-.92	.20	-9.64
Mb	400	-7.85	-7.85	12.37	-2.98	.70
Dl	200	-.19	-.19	-.05	-.29	.28
y	2.95E+08	-.53	-.53	-.14	-.12	.07
Real income	(thousand DA)					
CPI	1	-.08	-.08	-.02	.09	.74
Real y	2.95E+08	-.45	-.45	-.12	-.21	-.67
Government budget costs						
Producer subsidies						
Wheat	3900	-39.45	-39.45	.80	.00	.00
Barley	900	2.95	2.95	-46.17	.00	.00
Consumer tax (barley) and subsidy (wheat)						
Barley	700	-.13	-.13	-.04	68.55	.20
Wheat	3000	-.22	-.22	-.06	.10	-61.93
Total government budget cost						
	7100	-21.37	-21.37	-5.43	-6.72	-26.19
Balance of trade: import bills						
Wheat	10500	3.56	3.56	-.92	.20	-9.64
Barley	1200	-7.85	-7.85	12.37	-2.98	.70
Total	11700	2.39	2.39	.45	-.12	-8.57

Table 11M.2. A multimarket for the grain-livestock sector in North Africa: Income distribution

Data for Income distribution

Shares of profits by income group (rural households)

	Wheat	Barley	Livestock
Poor	.4	.4	.80
Middle	.1	.3	.15
Rich	.5	.3	.05

Rural incomes structure

	Wheat	Barley	Livestock	Other
Poor	.103	.028	.100	.769
Middle	.030	.024	.022	.924
Rich	.240	.039	.012	.709

Budget shares in consumption by income group (percentage)

Rural and urban	Wheat	Livestock
Poor	8	2
Middle	6	4
Rich	4	10

Base incomes per capita (DA/head)

	Rural	Urban
Poor	8000	12000
Middle	16000	18000
Rich	30000	35000

Population (millions)

	Rural	Urban
Poor	7	6
Middle	3	3
Rich	1	1

Results of policy experiments on income distribution

Policies		Initial value	Policy	Copy of policy results			
	ΔPwp	4800	-10	-10	0	0	0
	ΔPbp	3900	0	0	-10	0	0
	ΔPbu	3500	0	0	0	10	0
	ΔPwc	3000	0	0	0	0	10
Nominal income							
	Rural	(DA/head)	(% change)	(% change over initial values)			
	Poor	8000	-1.21	-1.21	-.33	-.49	.28
	Middle	16000	-.34	-.34	-.25	-.11	.06
	Rich	30000	-2.42	-2.42	-.40	-.06	.03
CPI							
	Rural/urban	(Index)					
	Poor	1	-.04	-.04	-.01	.04	.86
	Middle	1	-.07	-.07	-.02	.08	.71
	Rich	1	-.19	-.19	-.05	.21	.68
Real income							
	Rural	(DA/head)					
	Poor	8000	-1.18	-1.18	-.32	-.53	-.57
	Middle	16000	-.27	-.27	-.23	-.19	-.65
	Rich	30000	-2.24	-2.24	-.35	-.27	-.65
	Urban						
	Poor	12000	.04	.04	.01	-.04	-.86
	Middle	18000	.07	.07	.02	-.08	-.71
	Rich	35000	.19	.19	.05	-.21	-.68

Exercise 11.2

Policy Simulation with a Multimarket for Brazil

1. Analysis of the Economic Structure

What crops are produced in the North? What share of the value of agricultural production do export products represent? Is subsistence agriculture (the minimum-price crops) in surplus or deficit? By how much?

The North produces primarily subsistence crops and a small quantity of export crops. Using producer prices to value production, export crops represent 1.44% of the value of production in that region. Subsistence crops are in large surplus, with consumption using one-third of production.

What share of the production of export crops is consumed in the country? What are the levels of indirect taxation and of export taxes on these products?

Export crops are heavily taxed, with a 20% export tax and a 13.5% indirect tax. At the national level, domestic consumption absorbs 50% of export crops production.

For wheat, what is the rate of protection on domestic production? What is the subsidy rate for consumers? What is the share of imports in total supply?

Both production and consumption of wheat are subsidized, with a 30% rate of protection for producers and a 22.7% rate of subsidy for consumers. Brazil imports 65% of its domestic consumption of wheat.

For the minimum-price crops, what is the level of protection? What is the indirect tax on consumers?

By prohibiting external trade and intervening with purchases on the market, the government indirectly influences the equilibrium market price of the subsistence crops. Comparing their price with the world market price, the crops are in fact protected, with a protection rate of 16.5%. Indirect taxes of 13.5% further increase the price paid by consumers, who are taxed overall at a 32.3% rate.

What are the elasticities of labor supply and demand for the Interior?

Only the Interior region has a labor market. The elasticity of labor supply is 0.05 (on the screen called miscellaneous), and the elasticity of labor demand for both the minimum-price crops and soybean production is –0.36.

Which goods are relatively more necessary or more luxury in nature? Characterize the substitution possibilities in consumption.

Necessities are commodities whose quantities consumed do not vary much as income increases or as prices change. Thus, they are characterized by low-income and price elasticities and tend to be consumed more by the poor. Minimum-price crops and soybean oil both have low price elasticities (–0.10 and –0.30, respectively), and wheat has the lowest income elasticity of all goods (0.22). By contrast, export crops can be considered luxuries, as they have high income and price elasticities. Wheat is a good substitute for the subsistence crops. If the price of subsistence crops increases by 10%, the demand for wheat increases from 5.8% to 8.3%, depending on the region. Oil has no good substitute.

Give an example of a product with an elastic supply and one with a low supply elasticity. Are there complementarities in production? What can you say about the substitution effects among products?

On the supply side, soybeans have a relatively high elasticity of supply (0.85). By contrast, the minimum-price crops have a very inelastic supply. All cross-price elasticities are negative, so all crops are competing economically in production.

2. Policy Simulations

Simulate the effects of a 10% increase in the consumer price of wheat. What is the impact of this policy on bread consumption, consumption of other foods (why? note the substitutions), the other prices (link this to the supply elasticities), the government budget, and the income distribution? Who gains and who loses? Explain why.

Results are given in Table 11M.3. A reduction in the bread subsidy is equivalent to an increase in the consumer price of wheat. Looking at the direct effect of a price increase only, if the consumer price of wheat increases by 10%, bread consumption should decrease by 5% (from the direct elasticity of –0.5), and consumption of other commodities should increase (by 0.7% for export crops and 0.5% for minimum-price crops). These increased demands would not affect the price of the export crops sector because it is a pure tradable, but it will affect the market and the producer price of the minimum-price crops. The amount of price increase depends on the demand and supply elasticities. Increased price induces increased production until an equilibrium between demand and supply is reached. Production of the other commodities also adjusts to the new price system. By substitution, wheat and soybean production declines. Export crops, with almost zero cross-price elasticities, are unaffected. The decline in soybean production induces a small rise in the equilibrium price of soybeans. The new equilibrium is obtained with a price increase of 2.97% for minimum-price crops and 0.56% for soybeans. Consumption of all commodities adjusts to this new price system, with a decline for wheat of 2.72% and an increase of 0.02% for soy oil, 0.27% for minimum-price crops, and 0.94% for export crops.

The policy reduces the government budget deficit because the bread subsidy is reduced. Some of the producers' support declines as production falls. Government revenues increase as indirect tax revenues surpass the reduction in export taxes.

As consumption of the export crops increases, exports decline to 5935.7 thousand MT (from 5992 in the base solution). Consumption of wheat declines by far more than production decreases, inducing a large decline in imports to 3920.8 thousand MT (from 4088.7 in the base solution). The net effect of the policy on trade is a 0.5% improvement in the balance of trade.

The decrease in the subsidy has the largest negative impact on urban poor and middle-income households, which spend the largest share of their income on wheat. The increase in the minimum-price crops affects all households, but particularly the rural and urban poor and middle-income rural households, as they spend as much as 30% to 40% of their income on these commodities. Real income increases for the richer farmers, who benefit from the producer price changes without being too negatively affected on the consumption side.

Simulate the effects of a 10% reduction in the wheat production subsidy.

The results are given in Table 11M.4. A 10% decrease in the wheat producer support price induces a decline in wheat production and, by substitution, an increase in the production of soybeans. From the supply elasticities, first-round effects should be a decline of wheat production by 3.6% and an increase in soybeans production by 0.7%. This, in turn, induces a decline in the equilibrium price of soybeans and a smaller change in the production structure (the equilibrium changes—including the consumption effects that will be discussed below—are a 3.44% decline in wheat production and a 0.16% increase in soybean production). Nominal incomes of all farmers decline in all regions where minimum-price crops are produced and, further in the South, where wheat is produced. This induces a decline in demand and, hence, a decline in equilibrium prices of minimum price crops and soybeans. The initial depression of wheat producer prices has spilled over to all other crops.

As wheat production declines more than consumption, the effect on the balance of trade is an increase in imports to 4152.1 thousand MT (from 4088.7 in the base solution), while exports of the export crops sector remain almost unchanged.

The net effect on the government budget is positive, despite some decline in indirect tax revenues.

Table 11M.3. Policy simulation with a multimarket for Brazil: Increase in the consumer price of wheat by 10%

Production				
Goods	Producer price CR$ / MT	Percent change	Production 1000 MT	Percent change
Brazil				
Export crops	34117	.00	11992	.00
Minimum price	30240	2.97	60294	.26
Wheat	37049	.00	2189	-.12
Soybeans	31932	.26	12904	.11
Soy meal	30823	.00		
Crushing demand			12400	.00

Government accounts and foreign trade			
Items	Old level (million CR$)	New level (million CR$)	Percent change
Wheat deficit			
Producer deficit	10332	10320	-.12
Consumer deficit	46053	29529	-35.88
Total deficit	56386	39848	-29.33
Revenues			
Income tax	435864	443977	1.86
Export tax	40885	40501	-.94
Total government effect	420364	444630	5.77
Foreign trade - net exports	576272	579138	.50

Consumption				
Goods	Consumer price CR$ / MT	Percent change	Consumption 1000 MT	Percent change
Brazil				
Export crops	38722	.00	6056	.94
Minimum price	34323	2.97	58155	.27
Wheat	27500	10.00	6109	-2.72
Soy oil	117206	.56	9202	.02

Income		Rural			Urban
		North	South	Interior	
Lowest 30%	Real	-.30	-.60	-.20	-1.20
	Nominal	1.10	.80	1.20	.00
Middle 50%	Real	.40	.00	.20	-.80
	Nominal	1.50	1.10	1.20	.00
Highest 20%	Real	.40	.00	.10	-.30
	Nominal	.80	.40	.50	.00
Total	Nominal	.60	.40	.60	.00

Table 11M.4. Policy simulation with a multimarket for Brazil: Reduction in the producer price of wheat by 10%

Production				
Goods	Producer price CR$ / MT	Percent change	Production 1000 MT	Percent change
Brazil				
Export crops	34117	.00	11992	.00
Minimum price	29324	-.15	60139	.00
Wheat	33344	-10.00	2116	-3.44
Soybeans	31701	-.47	12910	.16
Soy meal	30694	-.01		
Crushing demand			12408	.00

Government accounts and foreign trade			
Items	Old level (million CR$)	New level (million CR$)	Percent change
Wheat deficit			
Producer deficit	10332	2138	-79.31
Consumer deficit	46053	45966	-.19
Total deficit	56386	48104	-14.69
Revenues			
Income tax	435864	433722	-.49
Export tax	40885	40893	.02
Total government effect	420364	426512	1.46
Foreign trade - net exports	576272	574277	-.35

Consumption				
Goods	Consumer price CR$ / MT	Percent change	Consumption 1000 MT	Percent change
Brazil				
Export crops	38722	.00	5999	-.02
Minimum price	33283	-.15	57999	.00
Wheat	25000	.00	6268	-.19
Soy oil	116322	-.20	9203	.04

Income		Rural			Urban
		North	South	Interior	
Lowest 30%	Real	.00	.00	-.10	.10
	Nominal	-.10	.00	-.10	.00
Middle 50%	Real	.00	-.20	.00	.00
	Nominal	-.10	-.20	-.10	.00
Highest 20%	Real	.00	-.30	.00	.00
	Nominal	.00	-.30	-.10	.00
Total	Nominal	.00	-.20	-.10	.00

Exercise 12

The Economics of Food Subsidies in a Computable General Equilibrium Model

1. *Assume a 10% subsidy in the food sector. What is the impact on sectoral real outputs, government surplus, investment, trade deficit in foreign currency, aggregate GDP and absorption, and the real income indices of households? Compare your results with the original presubsidy equilibrium.*

The results are given in Table 12M.1. Introduction of a 10% food subsidy reduces the consumer price of food. Consumption of food then increases. Using the parameters of the LES demand system, the direct price elasticity of food consumption for all classes is equal to 0.4 (see Chapter 2 for these formulae). Consumption should thus increase by 4%. This increased demand puts pressure on the food market, and the equilibrium price increases. In response, both domestic supply and imports increase. At equilibrium, we see that the producer price has increased by 1% (hence, the consumer price declines by 9% only), domestic production increases by 2.7% (cell G96 in Table 12M.1), and imports by 4.4% (G110). The income effect of the subsidy induces an increase in demand for the other two commodities. Because we only have relative prices, however, not all three prices increase. Relative to each other, the pressure on price is highest for food, then for agriculture, and finally for *Other*. Therefore, relative prices (relative to the aggregate price index set equal to one) increase for food and agriculture by 1% and 0.8%, respectively, and decline for *Other* by 0.3%.

On the supply side, sectoral production is only a function of the quantity of labor employed, since the other factor, capital, is fixed. Labor demand itself is a function of the cost of labor relative to the price of output. However, taking into account the cost of intermediate input, what really matters for the profit-maximizing producer is not the price of the product but the price of the product less the cost of intermediate input, which is sometimes called the value-added price. For the sector *Other*, the decrease in intermediate inputs induces a very small increase in the value-added price (0.434 in cell D56 compared with 0.433 in the base solution). Wages are exogenous and constant. Hence, relative labor cost decreases a little even for this sector for which the product price decreases. This explains the very small increase in production, by 0.1% (G97). Production in all three sectors has increased because employment has risen; this is possible because of the assumption of a fixed nominal wage and labor surplus in the economy. In aggregate, this results in a 0.4% increase in GDP (G87).

For the households, the combination of increased labor income and profits and decreased food consumer prices induces an important increase in real income of around 3%. The real income increase is slightly higher for the poorest groups due to their larger food income share.

Food subsidies cost 1597 million DH (F104), which inflates the government deficit by 75%, from 2003 to 3498 million DH (cells B105 and F105). This deficit is a negative savings in the aggregate savings (in other words, the government borrows this amount on the domestic credit market). Hence, investment declines by 6.6% (G90). Absorption, which is equal to

private and government consumption plus investment and represents the aggregate domestic acquisition of goods, increases by 0.4%.

As food imports increase, the trade and balance-of-payment deficits increase by 1.2% and 1.7%, respectively. We assume that foreign credit is available to cover this deficit, which allows the exchange rate to stay constant.

In conclusion, this policy of food subsidies clearly benefits the consumers; real incomes increase in all classes. It also has a Keynesian effect in inducing some growth of the economy, which was operating under a labor surplus. But these benefits are obtained at the cost of an increase in the external balance and a sharp decline in investment.

2. *Assume the food subsidy is paid by increased taxation on the rich. Compare outputs, government surplus, aggregate GDP and absorption, and household real income indices with those of the pre- and postsubsidy equilibria.*

By tatonnement, one finds that the necessary level of taxation on the urban rich is 17.5%. In terms of the effect on consumption, prices, and domestic production discussed above, the decline in income for the urban rich reduces the demand for private consumption. However, since investment is now maintained, the loss in consumer demand is compensated by an increase in demand for investment goods. This represents a shift in the structure of demand, with less demand for food and more demand for the *Other* sector. This translates into a relatively lower increase in production of food and a higher increase in the other two sectors. Aggregate GDP and absorption growth rates of 0.4% are maintained. The clear losers are obviously the urban rich households, which have been forced to pay for the food subsidy program. While attractive in terms of poverty reduction, this policy package may be difficult to implement politically.

3. *Assume the food subsidy compensated by government expenditure reductions. Compare with previous equilibria. Who is really paying for the subsidies in this case?*

The alternative explored here is to cut the level of government current expenditures by 9%. These expenditures pay for administration and public services. In the aggregate economy that we consider here, administration and public services are aggregated in the large sector called *Other*. Hence, the decline in government current expenditures corresponds to a decrease in the demand for this sector. This induces a decrease in its production compared with the first experiment and a decrease in the employment and income that the sector distributes to the economy. This can be seen in aggregate by a lower GDP increase compared with the first experiment (by 0.3% instead of 0.4%). The cost of this decrease in government public services is, hence, largely paid by those who were employed by the sector. Looking at the structure of value added in the *Other* sector, one sees that the cut in activity will induce a decline in labor, firm, and urban household incomes. Labor and firm incomes are mostly distributed to urban households. Hence, it is these urban households which, by losing the income they receive from the administration, pay the cost of the food subsidy. Because the economy is very aggregated in this particular example, the effect is quite diffuse. In a more disaggregated model, with a public administration sector and a public employee category of labor, one would see very specifically the effect of the decline on this group of wage earners. The second effect (not represented in this and many other CGEs) is the decline in the availability of public services—particularly education and health services—delivered free to the households. To properly take this into account, one would have to impute a utility or income equivalent to the users of these services in proportion to the level

supplied. This can be implemented in this model by creating a utility account for each household, where utility is equal to real income plus a fraction of the level of government real current expenditures. As an example, this has been done in rows 114–17, by arbitrarily considering that 40% of the current government expenditures is devoted to education and health and that this is distributed to the different classes with 30%, 50%, and 20% for the rural, urban low-, and urban-high income households, respectively. The result, in utility terms, is that the increase in welfare is lower than the increase in income. Hence, even the rural household now loses compared with the first experiment.

4. *Assume the food subsidy is paid by foreign aid. Compare the results with those of the previous policy experiments.*

To maintain the initial level of investment, a 22.1% increase in foreign capital inflow (6698 million of foreign currency) is needed when the subsidy policy is implemented. This corresponds to an exchange rate appreciation of 2.9%. The causality of the different effects can be interpreted as follows: The government maintains the level of investment by calling upon foreign borrowing. Hence, private consumption is allowed to increase while investment and real government expenditures are maintained. The sum of all these expenditures, which is absorption, increases by 2.4%. The cost is partially covered by foreign resources. Since so much foreign exchange is available, its cost decreases (relative to the domestic price index); therefore, a large part of the demand shifts to imports. This is why the trade deficit increases by 17.7%. In terms of household welfare, real incomes increase by 3.6% to 4.3%, more than with any other policy package analyzed previously. In this case, the cost of the food subsidy is borne by foreign aid. If it is foreign borrowing rather than foreign aid, those who really pay for the food subsidy program are the future generations left with debt. If the funds are from aid, then no reimbursement will be needed. Note, however, that foreign aid induces an appreciation of the real exchange rate, which is relatively unfavorable to the more tradable sectors and favorable to the nontradable sectors. At the level of aggregation that we consider here, this difference is not very visible. However, growth of the *Other* sector—the least tradable of the three sectors with a substitution elasticity of 0.8 in the import aggregation function—is higher under this real exchange rate appreciation (0.5% compared with 0.1% in the first experiment), while growth of the other sectors is equal or lower.

	A	B	C	D	E	F	G	H	I	J	K	L	M
80	**Table 12M. Food subsidy policy with alternative financing: simulation with a CGE**												
81													
82													
83								Alternative financing					
84		Base	Active	%		Government deficit		Income tax		Cut in govt. expend.		Foreign debt	
85		value	column	change		Value	% change	Value	% change	Value	% change	Value	% change
86													
87	Real GDP	63779	63779	0.0		64014	.4	64025	.4	64000	.3	64179	.6
88	Absorption	80782	80782	0.0		81103	.4	81112	.4	81062	.3	82701	2.4
89	Trade deficit ($)	6692	6692	0.0		6776	1.2	6770	1.2	6756	1.0	7876	17.7
90	Investment	17933	17933	0.0		16752	-6.6	17950	.1	17946	.1	17950	.1
91	Exchange rate	1.00	1.00	0.0		1.00	3.00	1.00	.00	1.00	.00	0.97	-2.90
92	Current deficit ($)	5484	5484	0.0		5575	1.7	5568	1.5	5554	1.3	6698	22.1
93	Sectoral performance												
94	Real supply												
95	Agriculture	23567	23567	0.0		23711	.6	23732	.7	23780	.9	23704	.6
96	Food	16057	16057	0.0		16489	2.7	16386	2.0	16491	2.7	16463	2.5
97	Other	107344	107344	0.0		107464	.1	107517	.2	107338	.0	107869	.5
98	Producer prices												
99	Agriculture	1.000	1.000	0.0		1.008	.8	1.010	1.0	1.013	1.3	1.006	.6
100	Food	1.000	1.000	0.0		1.010	1.0	1.005	.5	1.011	1.1	1.005	.5
101	Other	1.000	1.000	0.0		.997	-.3	.997	-.3	.995	-.5	.998	-.2
102	Government												
103	Basic tax on food	127	127	0.0		132	3.7	130	2.5	132	3.9	131	3.1
104	Food subsidies	0	0			1597		1576		1600		1594	
105	Govt. surplus	-2003	-2003	0.0		-3498	74.6	-1979	-1.2	-2287	14.2	-3304	64.9
106	After-tax real income												
107	Rural hh	17490	17490	0.0		18073	3.3	18110	3.5	18147	3.8	18128	3.6
108	Urban low hh	24636	24636	0.0		25326	2.8	25313	2.7	25278	2.6	25548	3.7
109	Urban high hh	15710	15710	0.0		16191	3.1	14656	-6.7	16156	2.8	16382	4.3
110	Food imports	1986	1986	0.0		2073	4.4	2043	2.9	2077	4.6	2145	8.0
111													
112						Food subs +10%		Tax urb. hi = 17.5%		Govt expend. -9%		Foreign K +22.1%	
113	Utility												
114	Rural household	19121	19121	0.0		19704	3.0	19740	3.2	19630	2.7	19759	3.3
115	Urban low hh	27354	27354	0.0		28044	2.5	28031	2.5	27751	1.5	28266	3.3
116	Urban high hh	16797	16797	0.0		17279	2.9	15743	-6.3	17145	2.1	17469	4.0
117													