PN-ABC-600

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APAP Microcomputer Tool No. 2: "POLYANA: A Microcomputer program and Methodology for the Analysis of Market Policies for a Single Commodity"

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POLYANA is a microcomputer program for analyzing the impacts of alternative policy interventions in the market for a single commodity. The program calculates and compares market equilibrium conditions under an existing policy, a free market policy and an alternative policy. Policies are compared in terms of their impacts on producers (quantity produced, farm level price, subsidy equivalent, and producers' surplus), on consumers (retail price, quantity consumed, subsidy equivalent, and consumer's surplus), on marketing agents, and on the public sector (budget surplus or deficit and net foreign exchange earnings). The overall net benefits or costs are summed for producers, consumers, marketing agents, and the public sector. The tool kit includes a manual covering the methodology and user friendly instructions for using the program and a computer disk with the spreadsheet templates and sample exercise data.

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WORK SHEET

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10. Abst

APAP Microcomputer Tool No. 2 is a microcomputer program for analysis of the effects of alternative policy interventions in the market for a single commodity. The program calculates and compares market equilibrium conditions under an existing policy set, under a free market policy, and under an alternative policy set.

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The user is encouraged to formulate an alternative policy or policies. The impacts of each alternative policy on producers, consumers, marketers, and the public sector are displayed along with the results of the current policy and of free trade. Policy interventions which can be studied include taxes, subsidies, quotas or allotments, and direct price supports or public marketing organizations.

The package includes a users manual and microcomputer discs with program and illustrative data.

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AGRICULTURAL POLICY ANALYSIS PROJECT

Under contract to the Agency for International Development, Bureau for Science and Technology, Office of Agriculture
Project Office 4250 Connecticut Avenue, N.W., Washington, D.C. 20008 • Telephone: (202) 362-2800

POLYANA:
A MICROCOMPUTER PROGRAM AND METHODOLOGY FOR THE ANALYSIS OF MARKET POLICIES FOR A SINGLE COMMODITY

APAP MICROCOMPUTER TOOL NO. 2

November 1988

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PART I: POLYANA (COMMODITY POLICY ANALYSIS)

INTRODUCTION

The document is presented in two parts. The first part explains the use of the POLYANA. The second part explains how selected policy interventions affect consumer and producer surplus. Suggestions are also given in Part II for methods of types of analysis which cannot be addressed with the microcomputer program.

POLYANA is a microcomputer program for the analysis of the effects of alternative policy interventions in the market for a single commodity. The program calculates and compares market equilibrium conditions under an existing policy set, under a free market policy, and under an alternative policy set.

Policies are compared in terms of their effects on producers (quantity produced, farm level price, subsidy equivalent, and producers' surplus), on consumers (retail price, quantity consumed, subsidy equivalent, and consumers' surplus), on marketing agents, and on the public sector (budget surplus or deficit, net foreign exchange earnings). The overall net benefits or costs are summed for consumers, producers, marketing agents, and the public sector.

The user is encouraged to formulate an alternative policy or policies. The impacts of each alternative policy on producers, consumers, marketers, and the public sector are displayed along with the results of the current policy and of free trade. The type of policy interventions which can be studied include taxes, subsidies, quotas or allotments, and direct price supports or public marketing organizations.

The POLYANA program is limited to cases where the producer and consumer reactions to price changes can be adequately represented with linear

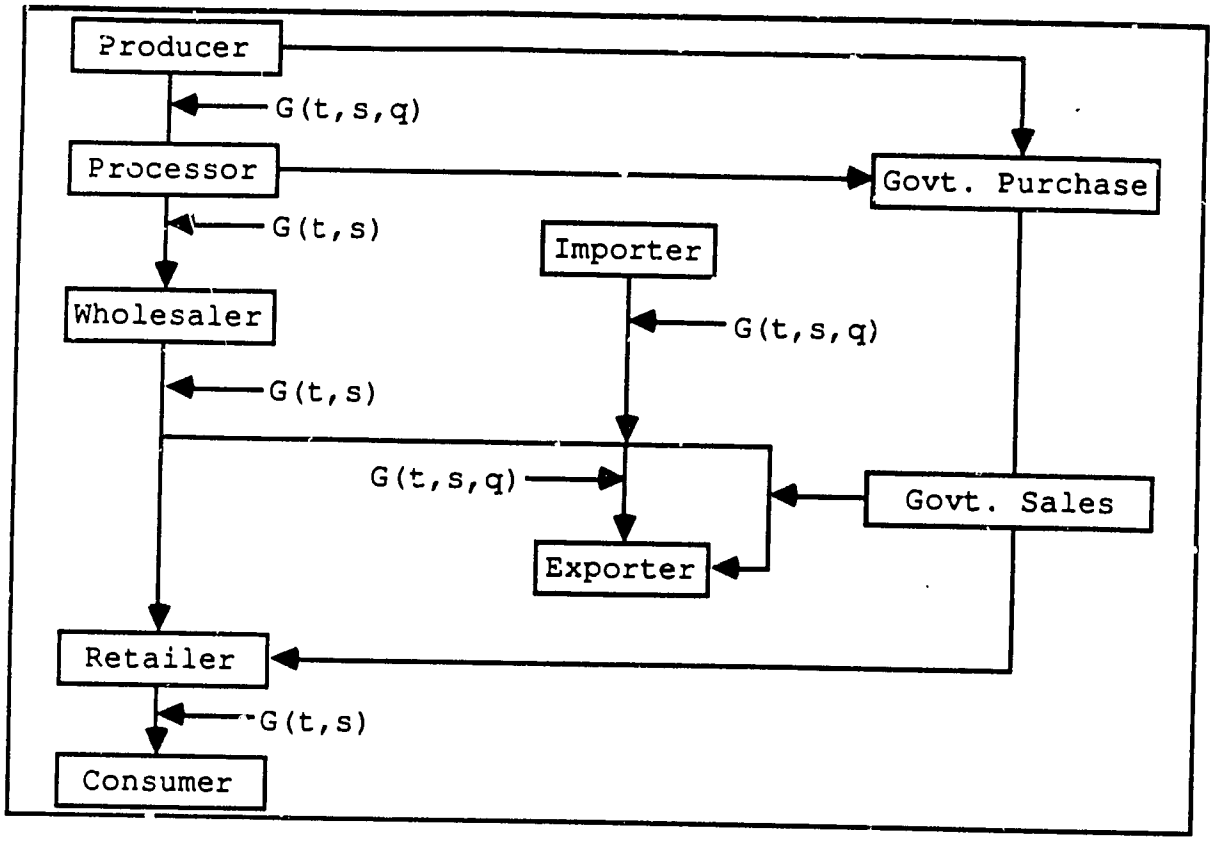

Figure 1. Schematic Diagram of the Market System and Type of Market Intervention Policies Which Can Be Analyzed by the POLYANA Program

response curves under competitive market conditions. The country is also assumed to be a price taker in exports and or imports. The cost of marketing and processing each commodity unit is assumed to remain constant regardless of the quantity marketed. Demand and supply relationships are assumed to be linear. However the user can simulate non-linear relationships by continuously revising the initial prices and quantities used to establish the supply and demand equations.

The market as seen by the POLYANA program is shown in the diagram below. Distinct variables are included to represent the producer, the processor or first handler, the wholesaler, the retailer, the importer, the exporter, and the

consumer. The types of policies and the points in the marketing chain where these policies might be implemented are indicated on the diagram. The admissible policies include taxes, subsidies, quotas and direct government marketing or price support activities. In the diagram below, the points where governmental taxes and subsidies can be applied are labeled G(t,s) and points where governmental taxes, subsidies or quotas can be applied are labeled G(t,s,q).

The economics of policy interventions in the production and marketing of a single commodity are described in great detail by Elz (1987), Houck (1983) and Tweeten (1988). The purpose of this program is provide the user with a mechanism to calculate the effects of many of the policy variations described by the above authors.

System Requirements.

The POLYANA program requires an IBM PC or IBM PC compatible micro computer with at least 256K RAM and one 360KB disk drive. MS-DOS version 2.0 or later is also required.

OVERVIEW OF THE PROGRAM

Conceptually, POLYANA consists of a series of input and output screens presented to the user in a natural order. The user moves from one screen to the next or previous screen by pressing the PgUp or PgDn key, respectively.

There are a total of four input screens and six output screens. The input screens are:

1. Model Parameter Input
2. Current Situation Input
3. Price Support Method Dialogue
4. Alternative Policy Specifications.

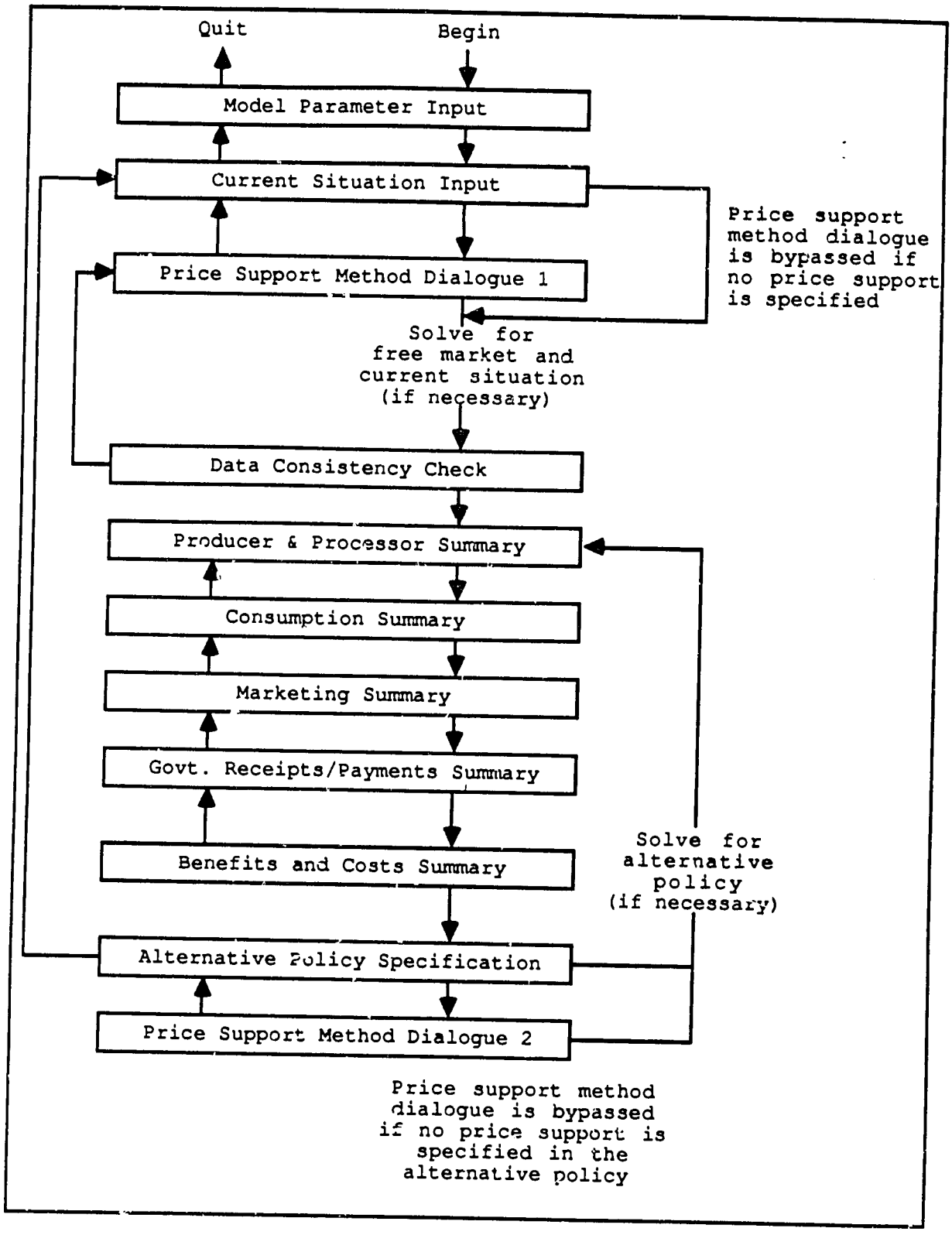

Figure 2. Schematic Overview of the Input-Output Steps for the POLYANA Program

The output screens are:

5. Data Consistency Check
6. Producer and Processor Summary
7. Consumption Summary
8. Marketing Summary
9. Government Receipts/Payments Summary
10. Benefits and Costs Summary.

Figure 2 depicts the flow of operation of POLYANA. The downward pointing arrows represent the <PgDn> key and the upward pointing arrows represent the <PgUp> key. As the program is entered, the user is presented with the Model Parameter Input Screen. After data entry has been completed for this screen, a press of the <PgDn> key leads to the Current Situation Input Screen. The user can press the <PgUp> key at any time to return to the Model Parameter Input Screen to review the parameters and/or make corrections if needed.

The Current Situation Input Screen requests, among other items, the producer price support level. If no value is specified, then pressing <PgDn> leads to the Data Consistency Check screen after a brief pause for model solving. If however a price support level is specified in Current Situation Input, then the user is first lead to Price Support Method Dialogue to identify, through a series of menu selections, how the support is implemented. Pressing <PgUp> here returns the user to Current Situation. Pressing <PgDn> leads to the Data Consistency Check Screen.

If consistency of the data is not satisfactory, then pressing <PgUp> returns the program to Current Situation Input screen where corrections can be made. Another press of the <PgUp> key returns the program to the first or Model Parameters Input screen. If the user is satisfied the initial information

shown in the Data Consistency Check, then pressing <PgDn> will lead to the first of a series of 5 output screens which summarize the results of the Free Market and Current Policies. Since the alternative policy has not yet been specified, this column is blank on the first pass.

From the first output screen, Producer and Processor Summary, pressing <PgDn> leads to the next output screen, and so on. At the last output screen, however, <PgDn> leads to the Alternative Policy Specification. Similarly, <PgUp> at each output screen except the first leads to the previous output screen. At the first output screen, <PgUp> leads to Current Situation Input.

After the alternative policy has been specified, pressing the <PgDn> key leads to a Price Support Dialogue if a price support level was specified. POLYANA then pauses briefly to calculate the results with the alternative policy, and again presents the user with the first of the 5 output screens. This time the output screen will contain figures for the alternative policy along with those of the current and free market policies. The user can flip between these 5 pages of results using the <PgUp> or <PgDn> key. At the last output screen, <PgDn> again leads to Alternative Policy Specification for specifying another alternative policy if desired. Pressing <PgUp> key at the Alternative Policy Specification screen leads the user back to the Model Parameter Input screen. Note that any time the model parameters or the current situation are altered the alternative policy and free trade results are recalculated.

To quit POLYANA, return to the first input screen, namely, Specify Model Parameters by repeatedly pressing <PgUp>. Press the <PgUp> key and select the Yes option to quit the program.

INSTRUCTIONS

STARTING THE PROGRAM

POLYANA is a stand-alone program which is executed from the DOS system prompt. The first time user should refer to the Appendix for instructions on copying POLYANA to a hard disk or for copying the DOS operating system onto to POLYANA program disk.

On a floppy disk system, the program should be in Drive A:. If a hard disk is used, be sure to invoke the POLYANA program at directory where it is stored. The instructions below assume the POLYANA program is on the disk in drive A. From the DOS system Prompt, type

A:> **POLYANA**

Units of Measurement. The physical units are arbitrary. However if units like kilograms or tons are used for a commodity which has a large volume of production, the number of digits may overflow the space available on the screen. In this case, the user should redefine the units in terms of thousands or millions of tons or kilograms. The per unit price should correspond to the quantity definition. When the quantities are in units such as thousands of tons and prices are in pesos per ton, then revenues and other benefit measures will automatically be in thousands of pesos.

AN ILLUSTRATIVE EXAMPLE

The following example illustrates the use of the program. In this example, a Government Marketing Organization (GMO) is used to increase the degree of self sufficiency in food production. Accordingly,

a. The GMO buys the processed product (Eg. white rice) at $498.80 per metric ton (mt). Net processing costs are $66.78 per mt of the unprocessed product. The weight of the processed product is 66.7% of the unprocessed product.

b. The GMO resells the product at the wholesale market price of $465.00 per mt. (Normal transportation and marketing costs are $68.10 per mt). Total domestic consumption is estimated to be 94.5 thousand metric tons (tmt). Actual retail prices are unknown.

c. The GMO charges an import tax of $32.91 per mt. on commercial imports. Current commercial imports are 50 thousand metric tons (tmt) at a CIF price of $419.50 per mt. The commercial importers' cost of moving the product into the domestic market is estimated to be 3% of the cif price.

d. The GMO receives 45.4 tmt annually of concessional imports from other countries.

f. Farmers currently produce 10 tmt of the unprocessed product for which they receive $264.60 per mt,

g. The respective elasticities of supply and demand are estimated to be 1.963 and -.60.

DATA ENTRY

Input Screen Number 1: Model Parameters

The initial entry screens are for the user to enter information which the program uses to find a market equilibrium under an existing set of policies. The initial entry screens are shown in Figures 3 and 4.

Please enter model parameters	
Elasticity of Supply.....	1.963
Elasticity of Demand.....	-.600
C.I.F. World Import Price.....	419.500
F.O.B. World Import Price.....	410.000
Retail Margin.....	0.000
Wholesale Margin.....	68.100
Ratio (Farm Weight/Retail Weight).....	.667
Net Processing Cost (Less Value By-Products).....	66.375
Importers' Margin (% of C.I.F.) Price.....	3.000
Implied Free Trade Price and Margins:	
Prices	
Farm Level.....	176.40
F.O.B. Processor.....	363.98
Wholesale.....	432.08
Retail.....	432.08
↑, ↓ moves cursor, <Enter> accepts entry, <PgDn> next screen, <PgUp> quits program	

Figure 3. User Input Screen Number 1, Model Parameter Input

The Actual data entry steps are;

Use the arrow keys and move the cursor to the desired cell
Type the entry
Press the Enter key or Up or Down Arrow keys
Move to the Next Cell, Type the entry
Use the Del key to remove an entry (to enter "None")
When all entries are complete,
Press the PgUp PgDn key to return to the previous screen
or
Press the PgDn key to go the next screen
Use the [Shift] PrtScr keys to print any screen
To Quit the Program, Press the PgUp Key until screen 1 appears, press PgUp one more time to Quit.

The initial data entries which are loaded with the program are intended only as examples but will be used unless the user replaces the original entries with more realistic estimates for his or her own commodity and country situation. The user should replace the original entries by moving the cursor to the appropriate cell and typing the correct value. Press the Enter key after the entry and the up or down arrow key to move to the next cell. When all entries are completed, press the PgDn key to go to the next user input screen. Press the PgUp key to return to the previous screen.

Elasticities and Border Prices

Price elasticity of supply and demand. The first data entries are for the price elasticity of supply and the price elasticity of demand. The program requires that the elasticity of supply be positive and that the elasticity of demand be negative. If the elasticity of supply is very large (almost perfectly elastic), attention should be given to placing an upper limit on exports. If the user is not aware of the elasticity of supply for a particular commodity, a recent study by Henneberry (1986) reviews elasticities of supply for many commodities around the world. If the user does not know the elasticity of demand, the negative of the

income elasticity of demand for that particular commodity can serve as an lower bound (upper bound in absolute value terms).

C.I.F. Import price. The CIF (Cost, Insurance and Freight) is the cost of having the commodity delivered to a port city for import. The CIF price must be entered in the country's own currency. The accounting or true exchange rate should be used when making the conversion. If a fixed exchange rate is used, the effect of the difference between the true and fixed exchange rate on the price of the commodity should be entered as a tariff or subsidy on importers. (See the discussion of overvalued exchange rates in Part II.)

F.O.B. export price. The FOB price (Free on Board) is the price which exporters are assumed to receive for the commodity when it has been loaded for export. The FOB price is given in the country's own currency. The user must first convert the international price of the commodity into the country's own currency. The true exchange rate should be used for this conversion. The effect of deviations between the true exchange rate and any other official exchange rate on the price of the commodity should be recorded as a tax or subsidy on exports. (See the discussion of overvalued exchange rates in Part II.)

The estimated prices which would prevail at the retail, wholesale, processor and farm level under a free trade import situation are shown at the bottom of the model input parameter screen. These prices are shown to provide a check on the marketing margins which have been entered.

The program does check to see that the FOB export price is less than the CIF import price. Should the export price be greater than the import price, a message will be displayed which warns the user that "traders would import an

infinite quantity for re-export" and that taxes, subsidies, or quotas must be revised before the program can continue.

Marketing Margins and Product Conversion Ratio

The constant marketing margins which are used in the model are entered by the user.

Retail margin. The retail margin is the difference between the average retail price paid by consumers and the average wholesale price or,

Retail Margin = Average Retail Price - Average Wholesale Price.

The margin should reflect the cost of moving the product from the point of where it is purchased from the wholesale merchant to the point where it is sold to the consumer. Taxes and subsidies should be removed from the margin and recorded separately as taxes or subsidies on retailers and or wholesalers.

Wholesale margin. The wholesale margin is the average cost of moving the product from the processor's plant or first handler to the point where the product can be sold to a retailer or to an exporter. The margin is calculated by subtracting the average fob processor price from the average wholesale price,

Wholesale Margin = Average Wholesale Price - Average Processor Price.

Processing or conversion ratio. The processing or conversion ratio converts the farm weight of the product into final market or retail weight. In the case of a commodity like rice, the weight of the white or polished rice may be about 67% of the weight of the paddy or hulled rice. For sugar cane, the weight of crude sugar may be only 10% of the weight of the sugar cane. If there is no processing or the product consumed at the retail is the same product defined at

the farm level the processing ratio is 1.0. The calculation for Processing or Conversion Ratio is,

$$\text{Processing ratio} = \frac{\text{Retail Weight}}{\text{Farm Weight}}.$$

Net processing cost. The net processing cost is the amount of the total cost for processing the farm product which is not covered by the sale of the by-products. For example, if the cost of ginning a bale of cotton is exactly covered by the value of the cotton seed, then the net processing cost is zero. A negative value is entered if the value of the by-products exceeds the cost of processing. The net processing cost for one unit (in farm weight) is equal to: Total cost of processing one unit - value of by-products in one unit.

Import or export margin. The importer's margin is the cost of moving the product from the CIF point to the retail merchant. Note that the margin is entered as a *percent* of the CIF cost. For simplicity, the exporters' margin (cost

Enter current production, prices, and policy variables	
Production at the Farm Level	
Quantity Sold.....	10.000
Price Received.....	264.600
Price Support Level.....	264.600
Production Quota.(<Del> to enter None).....	None
Consumption at the Retail Level	
Quantity Purchased.....	94.500
Price Paid.....	465.000
Price Ceiling or Maximum Price.(<Del> to enter None).	None
Import and Exports	
Commercial Imports.....	50.000
Import Quota.....	50.000
Import Tariff (Negative for Subsidy).....	32.910
Concessionary (Maximum Allowed).....	45.400
Per Unit Cost of Concessionary Imports.....	0.000
Commercial Exports.....	0.000
Export Subsidy (Negative for Tax).....	0.000
Export Quota.(<Del> to enter None).....	None
↑,↓ moves cursor, <Enter> accepts entry, <PgDn> next screen, <PgUp> prev screen	

Figure 4. User Screen Number Two, Current Situation Input

of moving the product from the point of wholesale to the point where the FOB price can be received) is assumed to be the same for both exports and imports.

When the user is satisfied with the entries, press the PgDn key to transfer to the screen shown in Figure 4. The second input screen (Figure 4) is where the user enters data to describe current production, prices, and policy variables.

Input Screen Number 2: Current Situation

Production and Consumption

The information on prices and quantities for production and consumption will be used with the respective elasticities to derive the supply and demand curves used in the analysis.

Production at the farm level. In the first section of the screen, the user is requested to enter the amount which is sold at the farm level and the price received under the current farm policy. (The analysis is conducted in terms of marketable surplus). The user should also enter any subsidies, price supports or production quotas which are in effect under the current agricultural policy. If there is no quota, the user should press the Del key (delete) for none rather than enter a "0". When the Del key is used, the word "None" will appear in the cell. A zero would be interpreted to mean that production of the commodity would not be allowed.

Consumers at the retail level. This is where the user should enter the current price and consumption levels at the retail level. The quantity entries here are national and not per capita. The respective quantity and price units (e.g. thousands of tons, pesos per ton) must be consistent with those used above for the farm level.

Imports and Exports

Imports and Exports are divided into two types, commercial and governmental.

Commercial Imports. Commercial imports are those where the buying and selling is done by the private sector. The user is requested to enter the level of commercial imports under the current policy along with any import quota or import tariff which is in effect. If there is no quota on imports, press the Del key for "None" rather than enter a zero. (A zero would be interpreted to mean that all imports are prohibited). The price and quantity units must agree with those used above.

Concessional Imports. Concessional or governmental imports would include those received under foreign assistance programs such as US PL480 and other relief assistance. The user is asked for the upper limit and the cost of the concessional imports.

Commercial exports. The commercial export section is similar to that for commercial imports. The user should enter the current level of exports along with any export subsidies or quotas which exist under the current policy. A tax on exports would be entered as a negative value. If there is no quota on exports press the Del key for "None" rather than enter a zero. A zero would be interpreted by the program to mean that all exports were prohibited.

Concessional exports. Any direct governmental exports are included as one of the options for implementing a government price support program which is discussed below. Policies which encourage or discourage commercial exports through taxes or subsidies (export enhancement, or export premium) are included with the commercial exports above.

METHOD OF IMPLEMENTING PRICE SUPPORT PROGRAMS OR GOVERNMENT MARKETING ORGANIZATIONS

When the user has finished entering the data, the PgDn key should be pressed. At this point the program will do some consistency checks on the data. If the user has indicated there is a commodity price support, a series of dialog boxes will appear in the screen (see Figure 5). The user will be asked to respond to some questions about how the price support policy will be implemented.

The options selected by the user will be highlighted on the screen. An example set of choices is shown in bold type in Figure 5. The program is capable of analyzing impacts of policies where,

a. The government purchases and stores the excess production. This program is similar to the United States commodity programs during the 1950s. If this option is selected, the user will be asked whether purchases will be made directly from the producer or from processors or first handlers.

b. The government buys production from farmers or first handlers and then resells the production to consumers or for export. Thus policies in which the sale of the commodities to retail consumers or exporters is subsidized can be analyzed. If this option is selected, the user will be asked further if

   1. the purchase is from producers or first handlers?

   2. the resale is to be to retailers, to export, or to either export or retail?

   3. if the resale price is to be determined by the market or is to be set by the policy maker? If the latter is chosen, the user will be prompted for the resale price.

c. The third type of direct commodity price support program is where the government pays the producer the difference between the market price and the support or target price. This type of program is similar to current US commodity support programs

```
Indicate how the price support policy will be implemented?
1. Govt purchase and storage of surplus production
2. Govt purchase with resale to exporters or consumers
3. Govt pays producers difference btw. market & support price

Indicate the method of government purchase
1. Purchase product directly from producers
2. Purchase product from first handlers or processors

Indicate where the product is sold
1. Resell to retail consumers only
2. Resell to exporters only
3. Resell to both consumers and exporters

Indicate at what price the product is sold
1. Resell at prevailing market price
2. Resell at a predetermined price

↑,↓ moves cursor, <Enter> accepts entry, <PgUp> next screen,
<Esc> last menu, <PgDn> defaults
```

Figure 5. Series of Dialog Boxes to Establish the Method of Implementing a Price Support or Government Marketing Policy

The program will also perform some logical checks. If the user has indicated for example that the government will support the farm price at a level above the CIF import price, the user will be cautioned that consumer will meet their consumption needs through imports rather than purchases from domestic producers.

```
                    ATTENTION
The support price of  290 is greater
than total import cost of  240.3
Therefor consumers will import, rather than buy domestic.
Either revise the tax or subsidy or use an import quota

                PRESS ANY KEY TO CONTINUE
```

The likely cause for this message is that the user forgot to limit imports.

DATA CHECK

After the data entry has been completed, the program will indicate that a free market solution is being calculated and then it will indicate that a solution under the current policy is being calculated. When the solution under the current policy set has been obtained, the computed results under the current policy set will be compared to the information entered by the user (see Figure 6). This gives the user an opportunity to proceed with the analysis using the computed results or to go back and revise the initial data. The computed results represent the programs estimation of an equilibrium solution. These may differ from the results entered by the user because, a) the actual data may have represented increases or decreases in ending stocks, b) one or more policy parameters may have been mis-specified (e.g. calculated imports exceed actual imports because there was a quota which was not included) or c) the data have been mis-specified.

Data Consistency Test: Compare Initial & Results from Model Solution

Item	Initial	Calculated	Difference
Farm Production (Farm Wt.)	10.00	10.00	0.00
Farm Price	264.60	264.60	0.00
Retail Consumption (Retail Wt.)	94.50	94.50	-0.00
Retail Price	465.00	464.99	0.01
Commercial Imports	50.00	42.43	7.57
Government Imports	45.40	45.40	0.00
Commercial Exports	0.00	0.00	0.00
Total Quantity Supply	102.07	94.50	7.57
Total Disappearance	94.50	94.50	-0.00

This program calculates a market equilibrium using the initial data provided by the user. Check the above results. Press the <PgDn> to go back to the former screen to revise the initial data or proceed with the analysis by pressing <PgDn>. The calculated values will be used in the rest of the analysis.

<PgUp> revise data, <PgDn> proceed with analysis

Figure 6. Screen Showing Data Check Point with Option to Revise Input Data

Producer & Processor Summary	Current Policy	Alternative Policy	Free Market
Producers' Market Price.....	264.60	.	176.40
Quantity Produced (Farm Level)...	10.00	.	3.46
Increase From Free Market.....	6.54	.	.
Producer Receipts.....	2646.00	.	609.81
Increase From Free Market.....	2036.19	.	.
Total Subsidy.Equivalent.....	881.97	.	.
Direct Per Unit Subsidy.....	.	.	.
Subsidy Per Unit of Production...	88.20	.	.
Total Producer Surplus (PS).....	673.97	.	80.54
Increase From Free Market.....	593.44	.	.
Quantity Processed (Market Wt.)..	6.67	.	2.31
Increase From Free Market.....	4.36	.	.
Value Added by Processors.....	663.75	.	229.45
Increase From Free Market.....	434.30	.	.
Output page 1, <PgUp> Last Page <PgDn> Next Page			

Figure 7. Output Screen Showing Effects of the Current and the Free Market Policy on Producers and Processors

CURRENT POLICY VS FREE MARKET ANALYSIS

The first output screen (shown in the upper part of Figure 7 compares the effects of the current and free trade policies on producers and processors. The impacts are measured through changes in price, quantity of production, total receipts, producers' surplus, and the subsidy equivalent.

EFFECT ON PRODUCERS AND PROCESSORS

The effect of the example policy on producer surplus is shown in Figure 8a and the effect on consumer surplus is shown in Figure 8b. The effects are divided because the farm level effects are shown in terms of the unprocessed quantity while the consumer effects are shown with the processed quantity.

In Figure 8a, the producer surplus under a free market policy would be area 1. Producer surplus under a price support policy would be equal to area 1 plus area 2. Area 2 represents the increase in producer surplus over the free trade situation.

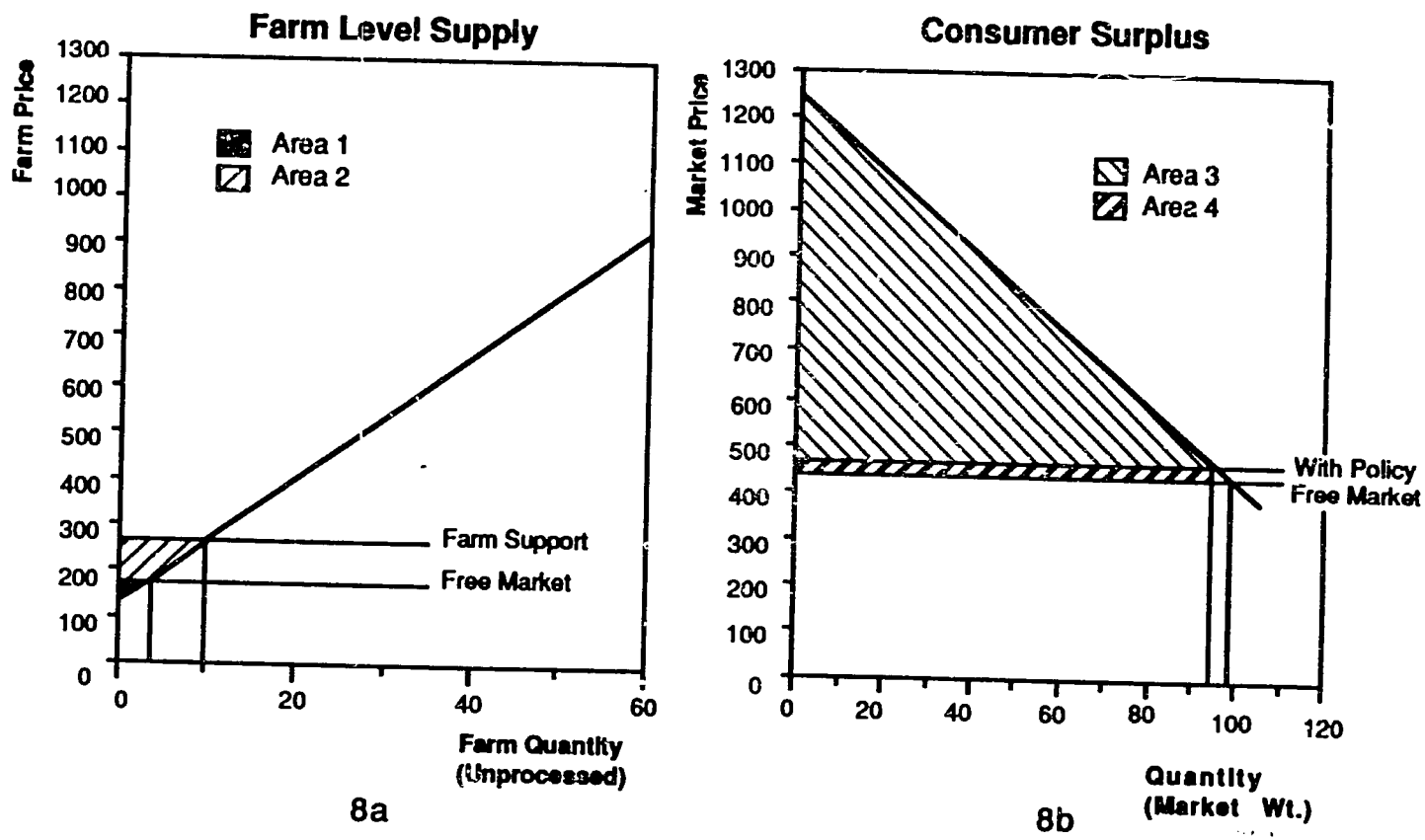

Figure 8. Illustration of Producer and Consumer Surplus

the consumer surplus under a free market policy would be equal to area 3 plus area 4. Under the example policy (farm price support plus an import quota), the consumer surplus would be only area 3. Area 4 represents the loss in consumer surplus from the example policy.

Two types of per unit subsidies are reported in Figure 7. The direct subsidy is the amount of a subsidy (negative if a tax) paid directly to the producer. In this program, the subsidy equivalent is the amount of direct subsidy that would be required in the free market situation to get the amount of output produced under the current policy set. The subsidy equivalent is calculated by multiplying the change in price between the two solutions by the amount of output in the current policy. The subsidy equivalent measures the effect of direct and indirect subsidies. An import tariff is an indirect subsidy in that the producer price is increased because domestic prices are increased.

In the numerical example, the general policy of a price support where the processed product was purchased from the processor increased total farm receipts because the GMO purchase price was higher (after marketing costs are considered) than the free market wholesale price. The higher price caused production to increase. The value of producer surplus or net farm earnings is estimated to be much higher under the current policy than it would be under a free trade policy.

The results from the example problem are used to illustrate the differential impacts of the current and free trade policies on the consumer as shown in Figure 9.

Consumption Summary	Current Policy	Alternative Policy	Free Market
Retail Quantity Consumed.....	94.50	.	98.51
Increase From Free Market.....	-4.01	.	.
Retail Price Paid.....	464.99	.	432.08
Increase From Free Market.....	32.91	.	.
Total Retail Expenditures.....	43942.31	.	42566.21
Increase From Free Market.....	1376.11	.	.
Subsidy Equivalent	-3110.02	.	.
Total Consumer Surplus.....	36619.22	.	39795.27
Increase From Free Market.....	-3176.05	.	.

Output page 2, <PgUp> Last Page <PgDn> Next Page

Figure 9. Output Screen Which Compares the Effect of the Current and the Free Market Policy on the Consumer

EFFECT ON CONSUMERS

The effects of alternative policies on consumers are compared through changes in the retail price, changes in the quantity demanded or consumed, changes in retail expenditures, changes in consumers' surplus and in the subsidy equivalent. The consumers' surplus is a measure of the benefits received by consumers because they pay less for the commodity than they would have been willing to pay. Consumers' surplus is the area under the demand curve and above the equilibrium price line in Figure 8. The subsidy equivalent for consumers is the amount of subsidy (or tax) that would have been necessary under the free market policy to produce the same consumption level as under the current policy set. The subsidy equivalent for consumers is calculated by multiplying the change in the retail price by the amount of consumption under the current policy set.

The impact of the price support policy is to reduce the value of consumers' surplus from what it would have been in the free trade situation. This is because the policy to increase agricultural producers' income has

increased the retail price. As a result of the increase in price, the level of consumption decreased.

POLICY EFFECTS ON THE MARKETING SECTOR

Figure 10 shows the output screen comparing the effect of the current and free trade policies on the marketing sector. The estimates of the value added by the wholesale, retail, and international trade sectors are calculated by multiplying the marketing margins by the quantity moving through the private marketing channels. Variations in the way policies are implemented can have considerable impacts on various segments of the marketing sector. For example, a policy of supporting prices by purchasing and storing excess production will reduce the value added by the marketing sector below that under a policy of supporting farm prices by purchasing farm production from first handlers and reselling at a lower price to exporters or retailers.

The item "Profit on Quotas" represents profits earned by traders who receive quota allocations. The profits are calculated by multiplying the quantity traded by per unit profit. For imports, the per unit profit is the domestic price less the cif price, the tariff, and margin. For exports, the per unit profit is the fob price less the domestic price, taxes, and margins. However the "profit" is zero if the quota is not limiting.

Marketing Summary	Current Policy	Alternative Policy	Free Market
Total Domestic Wholesale Quantity...	.	.	2.31
Increase From Free Market.....	-2.31	.	.
Value Added at Wholesale.....	.	.	157.01
Increase From Free Market.....	-157.01	.	.
Total Retail Quantity.....	87.83	.	98.51
Increase From Free Market.....	-10.68	.	.
Value Added at Retail.....	.	.	.
Increase From Free Market.....	.	.	.
Total Commercial Imports.....	42.43	.	97.21
Increase From Free Market.....	-53.78	.	.
Concessionary Imports.....	45.40	.	0.00
Total Exports.....	.	.	.
Increase From Free Market.....	.	.	.
Profit from Trade Quotas.....	.	.	.
Value Added, Exports and Imports...	533.99	.	1210.78
Increase From Free Market.....	-676.79	.	.
Profit from Trade Quotas	.	.	.

Output page 3, <PgUp> Last Page <PgDn> Next Page

Figure 10. Output Screen Which Compares the Effect of the Current and Free Market Policy on the Marketing Sector

Net Government Receipts from Taxes & Payments for Subsidies	Current Policy	Alternative Policy	Free Market
Farm Producers.....	.	.	.
Processors.....	.	.	.
Wholesalers.....	.	.	.
Retailers.....	.	.	.
Consumers.....	.	.	.
Commercial Importers.....	1396.39	.	.
Own concessionary Imports.....	.	.	.
Commercial Exports.....	.	.	.
Government			
Quantity purchased.....	6.67	.	.
Value of Purchases.....	-3309.75	.	.
Quantity Sales.....	6.67	.	.
Value Sales.....	3101.52	.	.
Public Budget Surplus (Deficit).	1188.16	.	.
Net Foreign Exchange Earnings...	-17799.64	.	-40359.21

Output page 4, <PgUp> Last Page <PgDn> Next Page

Figure 11. Output Screen Comparing the Effect of the Current and the Free Trade Policy on the Public Sector

POLICY EFFECTS ON THE PUBLIC SECTOR

The effect of current and free trade policies on the public sector is shown in Figure 11. Government receipts from taxes and expenditures from subsidies at various points in the marketing chain are summarized along with Government purchases and sales. These values show the distribution of gains and losses through the public treasury. If the objective of a tariff is to raise revenue, the user can experiment with various tariff rates and determine the rate which produces maximum government revenue. The value of foreign exchange earnings from imports or exports from the commodity policies being analyzed are also shown. In the example analysis, the "current" policies which include price support and import tariff reduce imports and hence reduce foreign exchange requirements.

NET SOCIAL ANALYSIS

The distribution of gains and losses from market intervention policies between producers, consumers, marketers, and the public sector are summed and compared in Figure 8. The net social benefit for each policy set is calculated as the sum of producers surplus plus consumers' surplus plus marketers' surplus + Government surplus. The benefits received by each group under the current policy are compared with the benefits received under the free trade policy.

In the example analysis, the current policy set which includes a producer price support along with import tax and import quota, provides gains for the producer and government sectors but losses for consumers. The final results indicate that net social benefit is lower under the current policy than it would be under a policy of free trade.

The sub-menu at the bottom of the screen permits the user to review the current policy set or to move to the next screen.

FORMULATION OF AN ALTERNATIVE POLICY

After reviewing the results of the current policy the user will likely wish to specify an alternative policy and repeat the analysis. The alternative policy is developed by changing the values for taxes, subsidies, quotas and the price support level in the screen in Figure 13.

Summary of Benefits and Costs by Economic Groups	Current Policy	Alternative Policy	Free Market
Producer Surplus.....	673.97	.	80.53
Increase From Free Market...	593.44	.	.
Consumer Surplus.....	36619.22	.	39795.27
Increase From Free Market...	-3176.05	.	.
Profit on Quotas.....	.	.	.
Government Surplus (Deficit)..	1188.16	.	.
Net Social Benefit.....	38481.35	.	39875.80
Increase From Free Market...	-1394.46	.	.

Last output page, <PgUp> Prev Page <PgDn> Set/revise alternative policy

Figure 12. Output Screen Showing a Comparison of the Effect of the Current and the Free Market Policy on the Distribution of Benefits

Specify Alternative Policy

Group Affected	-Last Solution- Quantity	Price	Subsidy	Taxes	Quota	Price Support
Farm Producers.....	10.00	264.60	0.00	0.00	None	264.60
Agric. Processor.....	681.00	496.22	0.00	0.00		
Wholesalers.....	0.00	464.99	0.00	0.00		
Retailers.....	87.83	464.99	0.00	0.00		
Consumers.....	94.50	464.99	0.00	0.00		
Commercial Importers.	42.43	464.99	0.00	32.91	50.00	
Governmental Imports.	45.40	0.00	0.00	0.00	45.40	
Commercial Exporters.	0.00	397.70	0.00	0.00	None	

↑,↓move, <Enter> accepts <PgDn> next step <PgUp> cur. sit. F1 narrative

Figure 13. Input Screen for Specification of an Alternative Policy Set

The initial values which will appear on the screen in Figure 13 are the values used in the last policy analyzed. The price levels and production levels

shown on the screen are from the last policy analyzed. These prices and quantities are shown for reference and do not change as the new policy set is developed.

The new policy is formed by moving the cursor to each cell where an entry is to be revised and typing the new value. If a quota is to be removed, the user should press the Del key rather than enter a zero, (As before, a zero is interpreted to mean that trade or production will be prohibited).

If the value of the price support is changed, the user will also be asked about methods of implementing the price support. The questions asked about the method of implementing the price support are the same questions asked with the second user-input screen shown previously with Figure 5.

When the user has finished revising the policy parameters, the PgUp or PgDn key is pressed, the program will check the logic of the policy parameters. If the final export price, (fob - tax + subsidy -margin) is less than the final import price (cif + tax - subsidy + margin), the user will be cautioned to revise the tax, subsidy or quota to prevent the case of infinite import and re-export. The next check occurs if a price support program has been implemented. With a price support, the program will ask the user to revise the policy parameters if the price that consumers must pay for domestic production exceeds the final import cost and there is no import quota.

The F1 (function key 1) can be pressed to display a narrative summary of the policy set. If the user presses the PgDn key, the program will calculate the effect of the Alternative Policy set and display the results of the Alternative policy along with the results of the Current and Free Trade policies. These output screens are the same as the screens shown in Figures 7-13 except that the results of the Alternative Policy set are shown along with the Current and Free

Trade Policies. The alternative policy can be revised and the process repeated indefinitely.

PART II: USING CLASSICAL WELFARE ANALYSIS TO ANALYZE COSTS AND BENEFITS OF GOVERNMENT INTERVENTION POLICIES

Classical welfare analysis (CWA) is a powerful analytical tool for measuring the economic benefits and costs of government involvement in the economy (see Tweeten). In the case of public goods, the market fails and benefits often exceed costs of government interventions to raise real national income. Here, however, we focus mainly on examples where government interventions in markets reduce full national income.[1]

EXAMPLES OF USES OF CLASSICAL WELFARE ANALYSIS

Figure 14 provides a generalized framework for classical welfare analysis. CWA separates costs (and returns) into those which are merely *transfers* from one group (consumers, producers, taxpayers) to another and those which are *deadweight costs* defined as those reducing full national income. The technique is sufficiently flexible to measure additions to real national income from correction for market failure such as externalities or for distortions in market such as government agricultural quotas, price supports, trade barriers, or subsidies.

Deadweight losses and output to maximize net social benefits (producer plus consumer surpluses) can be noted directly from Figure 14. For example, suppose that supply is S and demand is D for a commodity. We assume no externalities so that private costs (benefits) equal social costs (benefits). The area underneath the demand curve indicates the gross value consumers would

[1]National income is not the same as producer surplus plus consumer surplus which together measure net social benefit. The latter if measured properly come closer to measuring full income (including value of leisure) than does national income. However, net social benefit and national income are sometimes used interchangeably herein.

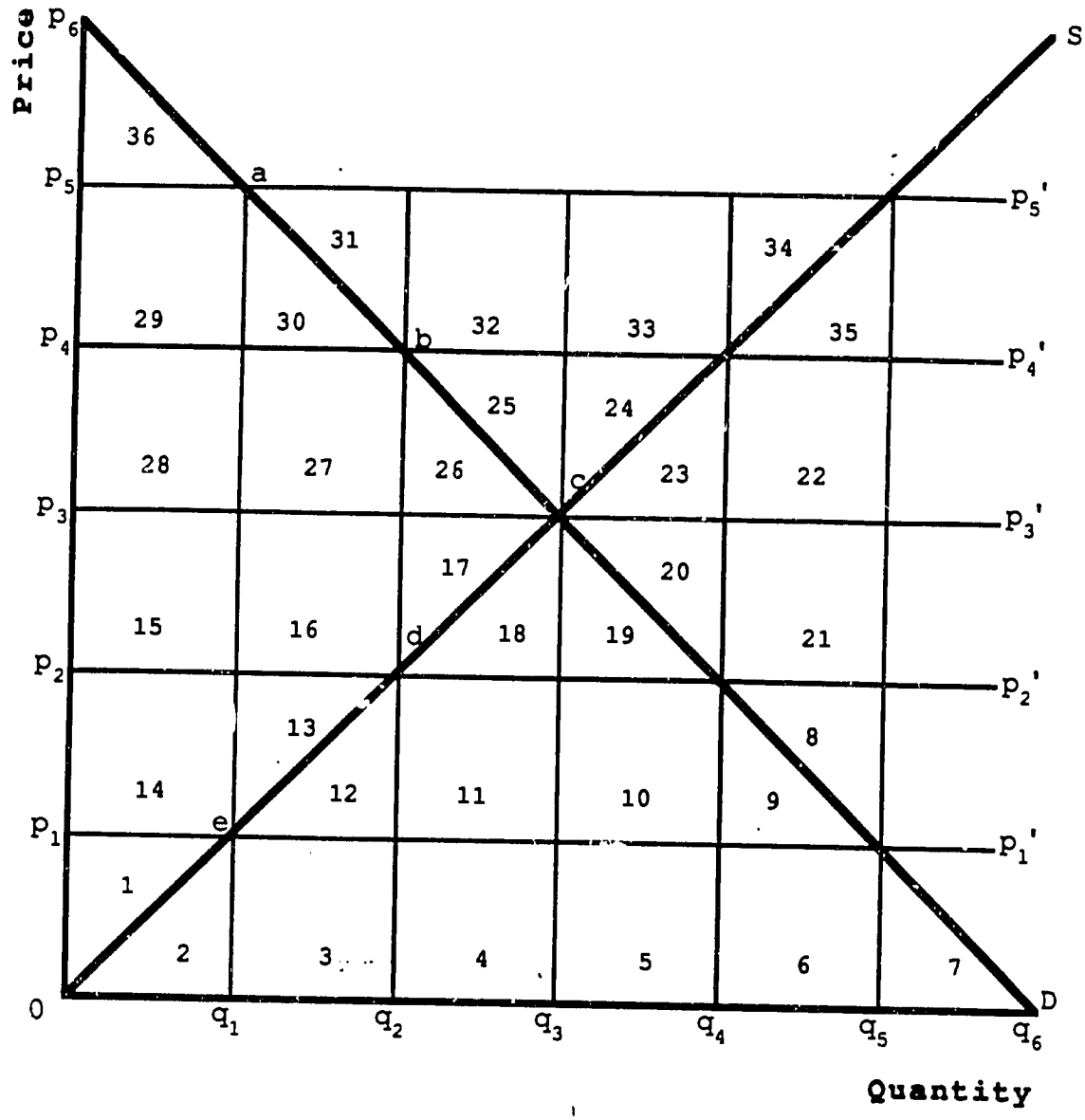

Figure 14. Illustration of Supply and Demand Mapping for Classical Welfare Analysis

be willing to pay for various quantities of the commodity. The area underneath the supply curve indicates the sum of variable costs of producing the commodity or, alternatively and equivalently, the value of consumption of *other* goods and services foregone by using resources to produce the commodity in Figure 14.

Net incremental real value of Q produced is positive moving from 0 to q_3 because D exceeds S but is negative to the right of q_3 because the value of

incremental gains D from directly consuming Q are less than the gains S foregone from not producing and consuming other commodities. Hence, net benefits are maximum (the triangle $0cp_6$) when output is q_3. Any other quantity sacrifices net social benefits by an amount called the *deadweight loss*. The maximum total benefit under a competitive market is divided into two portions -- the portion (triangle p_3cp_6) called the *consumer surplus* defined as the benefits consumers are willing to pay for in excess of the price p_3 they are required to pay, and the portion (triangle $0cp_3$) called the *producer surplus* defined as the excess revenue producers receive over what would compensate them for the cost of variable resources (triangle $0cp_3$) used to produce q_3.

Thus two types of deadweight or real net income losses are notable from Figure 14. One is from foregone benefits to consumers of Q when incremental demand benefits exceed price. For example, triangle 26 is the value of consumption of Q foregone (compared to equilibrium at price p_3 and quantity q_3) if the government intervenes to restrict the quantity. That is, from q_2 to q_3 consumers are willing to pay a higher price along D than the price p_3 they had to pay. Another deadweight loss is triangle 17 defined as the value of production foregone (again compared to equilibrium at price p_3 and quantity q_3) if the government intervenes to restrict the quantity to q_2. That is, from q_2 to q_3 producers earn a higher return p_3 than the incremental cost of production indicated by the supply curve S and thus sacrifice profit or a net return to fixed resources of value equal to area 17.

We shall note that areas such as 26 measured off the demand curve and 17 measured off the supply curve are generic in CWA — we encounter them over and over as deadweight losses under a wide range of distortions being analyzed. Hence, mastering their calculation allows us to measure deadweight losses associated with many types of situations.

QUANTIFYING DEADWEIGHT LOSS

For illustration, deadweight loss is measured from linear and constant-elasticity supply and demand functions. The private supply curve which indicates producers' response to price is assumed to equal the social supply curve showing how much real value of other goods and services is foregone by producing q. And the private demand curve showing the response of consumers to price is assumed to be equal to the social demand curve which measures real benefits to society of consuming q. Welfare analysis can be applied with appropriate adjustments to situation of externalities where these assumptions of private-social congruence do not hold.

Linear

If demand and supply relationships are linear, the typical functional form is

$$q = a + bp$$

where q is quantity supplied or demanded and p is price. The coefficient a is a constant representing the intercept. In supply analysis it is assumed factors such as technology and prices of inputs and competing products are held constant. In the case of demand analysis, income, tastes and preferences, and prices of complementary and substitute commodities are assumed to be constant. The slope b is negative for the demand function and position for the supply function.

Solving for p and taking the derivative, it is apparent that

$$\Delta p = \frac{1}{b} \Delta q.$$

1. Linear, Quantity Change Known

We can calculate the deadweight loss of a policy which causes consumption to decline from q_3 to q_2 if the slopes of the respective supply and demand curves are known. The slope coefficient is designated b_s for supply and b_d for demand. Because the area of a triangle is one-half the base times the height, it is apparent that

Area 26 $= .5\,(q_3 - q_2)\,(p_4 - p_3) = .5\,(q_3 - q_2)^2 / |\,b_d\,| = .5\,(\Delta q)^2 / |\,b_d\,|$ because $p_4 - p_3 = (q_3 - q_2) / b_d$.

Area 17 $= .5\,(q_3 - q_2)\,(p_3 - p_2) = .5\,(q_3 - q_2)^2 / b_s = .5\,(\Delta q)^2 / b_s$ where b_s is the slope from the supply curve.

2. Linear, Price Change Known

In the above case Δq was assumed to be known and we solved for Δp. In other instances Δp is known and we solve for Δq. In that case

Area 26 $= .5\,(p_4 - p_3)^2\ |\,b_d\,| = .5\,(\Delta p)^2\,|\,b_d\,|$

and

Area 17 $= .5\,(p_3 - p_2)^2\,b_s = .5\,(\Delta p)^2\,b_s$.

Constant Elasticity

In many instances, we know only supply and/or demand elasticities and selected quantities or prices.

1. Constant Elasticity, Quantity Change Known

The change in price may be approximated by the formula

$$\Delta p = \frac{\Delta q}{q}\left(\frac{dp}{dq}\,\frac{q}{p}\right) p$$

where $\Delta q/q$ is the proportional change in quantity, the term in parenthesis is the absolute value of the price flexibility of demand or supply (inverse

of price elasticity) and p is a known benchmark price. Hence, it is apparent that as approximations

$$\text{Area 26} = .5 \frac{(\Delta q)^2}{q} \frac{p}{|E_d|} = .5 \frac{(q_3 - q_2)^2}{(q_3 + q_2)} \frac{(p_4 + p_3)}{|E_d|}$$

and

$$\text{Area 17} = .5 \frac{(\Delta q)^2}{q} \frac{p}{E_s} = .5 \frac{(q_3 - q_2)^2}{(q_3 + q_2)} \frac{(p_3 + p_2)}{E_s} .$$

2. Constant Elasticity, Price Change Known

If the price change is known, the quantity change can be approximated by the formula

$$\Delta q = \frac{\Delta p}{p} \left(\frac{dq}{dp} \frac{p}{q}\right) q$$

where $\Delta p/p$ is the proportional change in price, the absolute value of the demand or supply elasticity is in parenthesis, and q is a benchmark quantity. Thus, as approximations

$$\text{Area 26} = .5 \frac{(\Delta p)^2}{p} \frac{q}{|E_d|} = .5 \frac{(p_4 - p_3)^2}{(p_4 + p_3)} \frac{(q_3 + q_2)}{|E_d|}$$

and

$$\text{Area 17} = .5 \frac{(\Delta p)^2}{p} \frac{q}{E_s} = .5 \frac{(p_3 - p_2)^2}{(p_3 + p_2)} \frac{(q_3 + q_2)}{E_s} .$$

Arc elasticities are used, i.e. q is approximated by .5 $(q_3 + q_2)$ and p by .5 $(p_4 + p_3)$ or .5 $(p_3 + p_2)$ in the above formulas. Sometimes in the actual calculations, only q_2, p_2, or p_4 is used instead of these averages. The approximations for the various areas calculated from above formulas become less exact as Δq or Δp become large. If they are large, the preferred approach is to obtain the double-log demand and supply functions; then integrate from q_2 to q_3 (or over the appropriate price range) to determine the areas of 17 and 26.

We now turn to examples of classical welfare analysis of various market interventions. Gains and losses are measured from equilibrium in the absence of interventions.

DOMESTIC MARKET INTERVENTION, NO EXPORTS OR IMPORTS

Assumptions

Domestic demand is D and domestic supply is S. Market equilibrium price is p_3 and quantity q_3 (Figure 14).

Intervention 1

Mandatory controls restricting output to q_2, giving price p_4.

Gain to producers	-17 + 27 + 28
Gain to consumers	-26 - 27 - 28
Gain to society	-17 - 26

Transfer inefficiency to producers is measured by the ratio of net social cost 17 + 26 to producer gain -17 + 27 + 28. *Transfer efficiency* to producers is the ratio of the gain to producers less the loss to society divided by the gain to producers.

Intervention 2

Price support to producers at p_4, no production control so producers supply q_4 which is subsidized $p_4 - p_2$ per unit of commodity to give consumers price p_2 and quantity q_4.

Gain to producers	+24 + 25 + 26 + 27 + 28
Gain to consumers	+15 + 16 + 17 + 18 + 19
Gain to taxpayers (subsidy)	-15 - 16 - 17 -18 - 19 - 20 - 23 - 24 - 25 - 26 - 27 - 28
Gain to society	-20 - 23

Intervention 3

Price support to producers at p_4, no production controls so producers supply q_4, government removes from market excess production $q_4 - q_2$ that is lost to spoilage or disposed of in other ways for no value at acquisition cost $p_4 - p_2$ per unit, and consumers obtain quantity q_2 at price p_4.

Gain to producers	+24 + 25 + 26 + 27 + 28
Gain to consumers	-26 - 27 - 28
Gain to taxpayers	-4 - 5 - 10 -11 - 17 - 18 - 19 - 20 - 23 - 24 - 25 - 26
Gain to society	-4 - 5 - 10 -11 - 17 - 18 - 19 - 20 - 23 - 26

EXPORT SUBSIDY

ASSUMPTIONS

Export demand without intervention is p_4p_4'. Domestic demand is D and supply is S. We assume a "small country" in this and latter examples. That is, changes in trade by the country do not influence world price. (In practice, adjustment can be made for world price changes in welfare analysis for a "large country" whose trade influences world price.) Total demand is p_6bp_4', equilibrium price is p_4, and equilibrium quantity (production) is q_4 with q_2 consumed in the domestic market and $q_4 - q_2$ exported.

Now assume that a subsidy of $p_5 - p_4$ per unit of exports brings domestic price to p_5. Exports expand to $q_5 - q_1$ because domestic consumption falls from q_2 to q_1 and output increased from q_4 to q_5. Compared to equilibrium without intervention, welfare analysis results are:

Gain to producers	+29 + 30 + 31 + 32 + 33 + 34
Gain to consumers	-29 - 30
Gain to taxpayers	-30 - 31 - 32 - 33 - 34 - 35
Gain to society	-30 - 35

EXPORT TAX

Assumptions

Export demand is p_5p_5'. Total demand (highest price for any given quantity without market intervention) is p_6ap_5' and price is p_5. Equilibrium total quantity produced is q_5, domestic consumption is q_1, and export is $q_5 - q_1$.

An export tax is imposed of $p_5 - p_4$ per unit exported. It cannot be passed to the foreign market (no one would buy). Then the new total demand curve is p_6bp_4', price is p_4, and total quantity is q_4 with domestic quantity consumed q_2 and exports $q_5 - q_2$.

Analysis

Welfare analysis results are as follows compared to equilibrium:

Gain to producers	-29 - 30 - 31 - 32 - 33 - 34
Gain to consumers	+29 + 30
Gain to taxpayers	+32 + 33
Gain to society	-31 - 34

Figure 14 can also be used to illustrate the impact of import tax or subsidy on producers, consumers, taxpayers, and the national economy. In each case domestic demand is D and domestic supply is S. Import supply is assumed to be perfectly elastic.

IMPORT TAX

Assumptions

Import supply without intervention is p_1p_1'. Hence, total supply at lowest supply prices, is $0ep_1'$, equilibrium price is p_1, and total consumption is q_5. Domestic quantity supplied is q_1 and imports are $q_5 - q_1$ for a total supply quantity of q_5.

Now assume an import tax of $p_2 - p_1$ per unit. This raises domestic price to p_2 and domestically supplied quantity to q_2 but reduces imports from q_5 to q_4. Total supply quantity and demand quantity are q_4.

Analysis

Welfare analysis is as follows:

Gain to producers	+13 + 14
Gain to consumers	-9 - 10 - 11 - 12 - 13 - 14
Gain to taxpayers	+10 + 11
Gain to society	-9 - 12

IMPORT SUBSIDY

Assumptions

Import supply without intervention is assumed to be p_2p_2'. The total supply curve is $0dp_2'$. Equilibrium price is p_2, domestically produced supply quantity is q_2, and total supply and demand quantity is q_4.

An import subsidy of $p_2 - p_1$ per unit is imposed, lowering domestic price to p_1, and expanding quantity demanded to q_5. Domestically produced quantity is q_1 and imports are $q_5 - q_1$ so that total supply quantity is q_5.

Analysis

Welfare analysis is as follows:

Gain to producers	-13 - 14
Gain to consumers	+9 + 10 + 11 + 12 + 13 + 14
Gain to taxpayers	-8 - 9 - 10 - 11 - 12 - 13
Gain to society	-8 - 13

OVERVALUED CURRENCY

Assumptions

An overvalued currency is an implicit tax on exports and an implicit subsidy on imports. If Figure 14 refers to a commodity being exported with export demand p_5p_5', the overvalued currency reduces real domestic price from p_5 to p_4.

Alternatively, using Figure 14 to refer to an imported commodity, the overvalued exchange rate reduces the real price from p_2 to p_1.

Analysis

The analysis is only an approximate short-run partial solution because an overvalued currency is not sustainable. As foreign exchange reserves dwindle, either the exchange rate must fall or reserves must be rationed. Supply and demand for foreign exchange based on accounting (shadow or market equilibrium) exchange rates would complete the welfare analysis. The commodity *welfare analysis* for the short run is:

1. Exported commodity (lower price from p_5 to p_4).

Gain to producers	-29 - 30 - 31 - 32 - 33 - 34
Gain to consumers	+20 + 30
Uncompensated foreign exchange transfer	-32 - 33
Gain to society	-31 - 34

2. Imported commodity (lower price from p_2 to p_1).

Gain to producers	-13 - 14
Gain to consumers	+9 + 10 + 11 + 12 + 13 + 14
Uncompensated foreign exchange transfer	-10 - 11
Gain to society	-9 - 12

PAYOFF TO PUBLIC RESEARCH TO DEVELOP NEW TECHNOLOGY

Figure 15 illustrates other uses of classical welfare analysis to measure payoffs from improved productivity of resources or from eliminating imperfect competition.

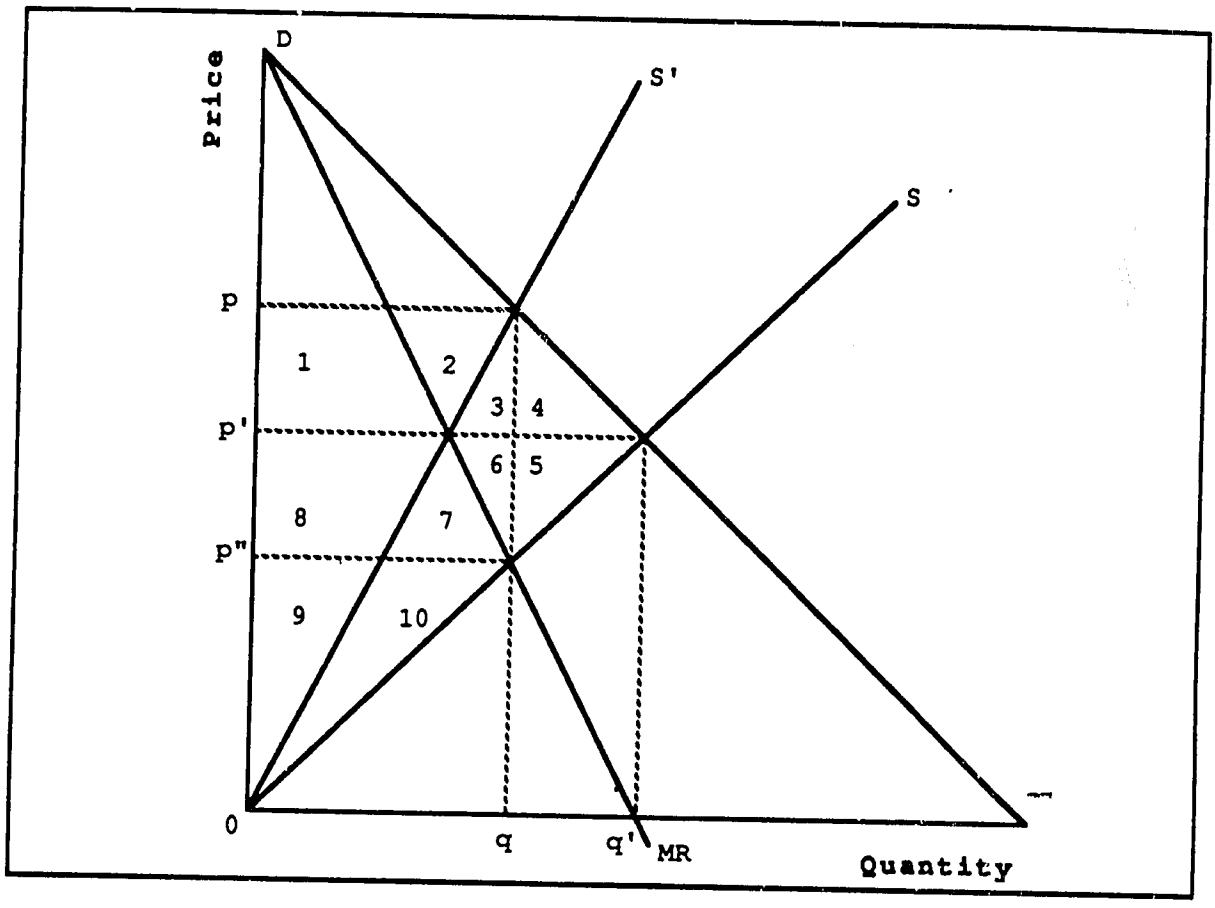

Figure 15. Illustration of Classical Welfare Analysis Under Shifting Supply and Imperfect Competition

Given demand curve D, suppose that public investment of C in research shifts the supply curve from S' to S in Figure 2. Equilibrium price falls from p to p' and quantity increases from q to q'.

Welfare analysis is summarized as:

Gain to producers	-1 - 2 + 5 + 6 + 7 + 10
Gain to consumers	+1 + 2 + 3 + 4
Gain to taxpayers	-C
Gain to society	+3 + 4 + 5 + 6 + 7 + 10 - C

The benefit-cost ratio for investment in research is (3 + 4 + 5 + 6 + 7) /C. Net benefit is (3 + 4 + 5 + 6 + 7) - C.

Benefits and costs are unlikely to be attained simultaneously. Technology may be regarded as a durable capital good where costs invested over a period of years give rise to benefits given off as an income stream over a period of years. Let costs C and benefits B be

$$C = c_1 + c_2 + \ldots + c_n = \sum_{i=1}^{n} c_i \qquad B = b_1 + b_2 + \ldots + b_n = \sum_{i=1}^{n} b_i$$

over n years (some c_i and b_i may be zero). Benefits and costs are discounted at a rate d to place all c_i and b_i on the same time basis.

The net present value, NPV, is

$$NPV = \sum_{i=1}^{n} \frac{b_i}{(1+d)^i} - \sum_{i=1}^{n} \frac{c_i}{(1+d)^i}$$

the benefit-cost ratio is B/C and the internal rate of return here is referred to as that value of d such that B - C = 0 or

$$\sum_{i=1}^{n} \frac{b_i}{(1+d)^i} - \sum_{i=1}^{n} \frac{c_i}{(1+d)^i} = 0.$$

THE SOCIAL COST OF MONOPOLY

Figure 15 also can be used to illustrate the social cost (deadweight loss) from imperfect competition. Assume industry demand is D and supply is S in Figure 15. Price and output under competitive conditions are then p' and q' respectively. If the competitive industry is organized and operated as a monopoly, output is q where marginal revenue, MR, equals marginal cost S, and price is p.

We examine losses of shifting from competitive pricing and output to monopoly. *Welfare analysis* results are summarized as follows:

Gain to producer	+1 + 2 + 3 - 5
Gain to consumer	-1 - 2 - 3 - 4
Gain to society	-4 - 5

THE SOCIAL COST OF MONOPSONY

Industry demand and supply are D and S with competitive equilibrium price p' and quantity q'. Now suppose the industry becomes a monopsony characterized by a single buyer of the commodity. The monopsonist maximizes returns where marginal resource cost S' equals marginal revenue (assumed to be D) so that quantity is q and price is p".

Now summarizing the welfare analysis, gains from shifting from competitive pricing and output to monopsony are:

Gain to producer	-5 - 6 - 7 - 8
Gain to consumer	+4 + 6 + 7 + 8
Gain to society	-4 - 5

LIMITATIONS

The Marshallian concepts of producer surplus and consumer surplus have been controversial as well as useful. Major criticisms and means to address them are listed below.

1. Consumer surplus is calculated from a demand curve ordinarily estimated from time series data. The historic price-quantity data used to estimate the demand curve are likely to be narrow in range. The shape of the demand curve outside the historic price-quantity data is unknown. Consumer surplus outside the historic price-quantity data range can be measured imperfectly at best. The appropriate means to alleviate the shortcoming is to estimate

consumer surplus only within the historic data range and only as the deviation from equilibrium as shown in the illustrations earlier.

2. A second major criticism of consumer surplus is that price as a measure of marginal utility and the area beneath the demand curve as a measure of total utility require constant marginal utility of income. Ideally, consumer surplus would be estimated from an income-compensated demand curve. Such a curve is not easily estimated. If the change in income is small from changes in consumer and producer surpluses being considered, error introduced by failure to adjust demand for changing marginal utility is small. Willig shows means to adjust for changing marginal utility of income when moving along the demand curve.

3. Marginal utilities differ among individuals, creating problems in using aggregate demand to measure utility. Although differences within groups such as consumers, taxpayers, or producers may average out, systematic differences are apparent between groups by income level. Classical welfare analysis applies to group rather than to individual behavior and hence, is well suited for policy analysis. Tweeten and Mlay provide empirically estimated marginal utilities that can be used to weight costs and benefits by income levels of recipients. An alternative is to simply show gains and losses to consumers, taxpayers, and producers by income groupings and leave to policy makers the task of assigning welfare weights.

4. Producer surplus is a return to fixed resources — a net return after subtracting variable costs from gross returns. Supply curves are behavioral relationships. They are imprecise measures of marginal

and total variable costs and hence, of economic rent in the long and short run. Often the best solution to this problem is to estimate producer surplus as gross receipts less all operating costs defined as costs which are variable in the time period under consideration. Estimates of operating costs may be available for commodities from farm management surveys or other sources.

5. Classical welfare analysis often is but need not be confined to a partial, single commodity analysis. Equilibrium prices and quantities ideally would account for interactions among commodities in a simultaneous system of demand and supply equations.

6. Long-run as well as short-run elasticities often are not but can be recognized in analysis.

7. Finally, classical welfare economics primarily relates to static economic efficiency and current income rather than to long-term efficiency and economic growth which requires savings and investment in high-return durable capital. Net social benefit may be consumed today or invested to produce future social benefits. If net social benefit is consumed today, it provides satisfaction today. If it is saved and invested, it provides a flow of future output benefiting later generations. The later will be apparent in dynamic efficiency. Dynamic efficiency can best be measured by trends in resource productivity, national income, or national income per capita. Historical data indicate that countries with the least amount of government interventions distorting prices (lowest net social cost) have had the fastest rates of economic growth (Agarwala).

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APPENDIX

INSTALLING THE DOS OPERATING SYSTEM ON THE PROGRAM DISK

The distribution disk does not have the MS-DOS operating system. If this operating system is copied onto the disk, the user can start the computer with the program disk in drive A:.

STEPS.

1. Place the disk containing the POLYANA disk in drive B:
2. Place a disk with the DOS operating system in Drive A:
3. Type B:FLPINST

The installation program will copy install a copy of MS-DOS on the program disk.

INSTALLING POLYANA ON A HARD DISK.

1 The POLYANA program can be installed in any directory. It is necessary to copy the example file and the POLYANA.EXE file to the user's hard disk directory. In the following example, it is assumed the users directory and path are C:\POLY but any existing directory can be substituted.

STEPS

a. Place the distribution diskette containing POLYANA in drive A:
b. Type A:HINST C:\POLY

The hard disk installation program will copy the necessary files to the directory C:\POLY (or the name substituted by the user).