

MPSGE Basic Maneuvers

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This section covers several “standard” MPSGE tools and concepts. Some concepts depend upon specific economic theory:

Concepts:

1. Intermediate Goods and Nested CES Functions
2. Joint Outputs
3. Sector-specific factors of production
4. Initially un-profitable activities
5. Endogenous labor supply
6. Informal labor supply
7. Multiple households



Intermediate Goods

[Home Page](#)

[Title Page](#)



Page 1 of 17

[Go Back](#)

[Full Screen](#)

[Close](#)

[Quit](#)

8. Stone-Geary preferences



Intermediate Goods

Home Page

Title Page



Page 2 of 17

Go Back

Full Screen

Close

Quit

1. Intermediate Goods and Nesting

We will use the basic M1 model as a template to build upon. The usual SAM has been changed slightly to reflect the addition of *intermediate inputs* into production:

Markets	Production Sectors			Consumers
	X	Y	W	
PX	120	-20	-100	
PY	-20	120	-100	
PW			200	-200
PL	-40	-60		100
PK	-60	-40		100

In this SAM, output from *X* is used as an *input* for *Y* and vice-versa. We can use the following \$prod: block to represent *Y* production:

```
$PROD:Y s:0.75 va:1
      O:PY Q:120
      I:PX Q: 20
      I:PL Q: 60 va:
      I:PK Q: 40 va:
```

- *Y* production uses *PX* and a value-added nest, with *PL* and *PK*.
- The value-added nest is Cobb-Douglass, while *va* and *PX* are combined in a CES with elasticity of a substitution, $\sigma = 0.75$.



1.1. Exercises:

1. Re-formulate the M1 model to reflect the SAM given above, use a *value-added* nest for labor and capital with $\mathbf{va}:1$ and $\mathbf{s}:0.75$.
2. Change the nesting structure, so that the X sector includes PY and PK in the nest. Change the top-level elasticity to $\mathbf{s}:0.5$. Apply a 100% *ad-valorem* tax on both *labor* and *capital* in the X sector (\mathbf{va} : nest. Determine the welfare cost of the tax.
3. Write the MCP formulation for this model.



2. Joint Outputs

Joint outputs are included easily using MPSGE. In this section, the SAM is reformulated so that each sector produces some of each commodity, X and Y . The SAM is listed below:

Markets	Production Sectors			Consumers	
	A	B	W	CONS	
PX	80	20	-100		
PY	20	80	-100		
PW			200		-200
PL	-40	-60			100
PK	-60	-40			100

To include outputs of both X and Y , add an output line to the production block. Notice that the sector names have changed from X, Y to A, B .

```
$PROD:A  t:2.0  s:1
          O:PX   Q:80
          O:PY   Q:20
          I:PL   Q:40
          I:PK   Q:60
```

We use a $t:2.0$ to denote the *output elasticity of transformation*. Output nesting is symmetrical to input nesting.



Intermediate Goods

[Home Page](#)

[Title Page](#)



Page 5 of 17

[Go Back](#)

[Full Screen](#)

[Close](#)

[Quit](#)

2.1. Exercises:

1. Apply a tax on the A sector. Determine the equilibrium activities and prices (A,B,X,Y) for the following set of tax rates and transformation elasticities:

	Tax Rate (TX_A)		
	0.1	0.5	1.0
t_A = 0.5			
t_A = 1.0			
t_A = 2.0			
t_A = 8.0			

2. Confirm the *revenue* function for the A sector. The standard functional form for CET functions is:

$$R(p_x, p_y) = \bar{R} \left(\theta \left(\frac{p_x}{\bar{p}_x} \right)^{1+\sigma} + (1 - \theta) \left(\frac{p_y}{\bar{p}_y} \right)^{1+\sigma} \right)^{\frac{1}{1+\sigma}}$$



Intermediate Goods

Home Page

Title Page



Page 6 of 17

Go Back

Full Screen

Close

Quit

3. Sector-specific Factors

Most industries require specific machinery, natural resources, or factories in production. Those industries with a high share of non-tradable capital tend to have decreasing returns to scale compared with sectors which can utilize a “generic” capital pool.

Heavy industries, such as coal-mining and electricity production, have difficulty expanding output in the near-term because they must utilize specialized capital which has a long lead time (4-7 years for new power plants).

Adding an additional specific factor to our standard SAM is straightforward:

Markets	Production Sectors			Consumers
	X	Y	W	CONS
PX	100		-100	
PY		100	-100	
PW			200	-200
PL	-25	-75		100
PK	-50	-15		65
PKX	-25			25
PKY		-10		10

3.1. Exercises:

1. Include sector-specific capital into the original M1 model.



Intermediate Goods

Home Page

Title Page



Page 7 of 17

Go Back

Full Screen

Close

Quit

2. Apply a 50% tax to the X sector. Compare the results with the same tax in the M1 model. What are the major differences? Would a tax on the X sector be more efficient than the Y sector?



Intermediate Goods

Home Page

Title Page



Page 8 of 17

Go Back

Full Screen

Close

Quit

4. Unprofitable Activities

The standard zero-profit condition is that costs are *at least* as great as revenues:

$$C(p) \geq R(p) \quad \perp Y$$

In a complementarity setting, the associated variable, Y , adjusts until $C(p) = R(p)$, as $R(p)$ falls, Y eventually hits its lower-bound, $Y.L0 = 0$.

In this section, we will include an unprofitable sector, Z , which becomes profitable in the presence of a tax.

4.1. Exercise:

1. Starting with the M1 template, create a new GAMS program. Define an additional sector, Z , which is identical to X , but which is also 10% less efficient.
2. Impose a 25% tax on inputs to the X sector.
3. Compare the welfare effects of a 25% tax in the presence of the Z sector, with welfare when Z does not exist (do this by fixing Z output to zero: $Z.FX = 0$. What is the effect if the tax rate is 100%?
4. Identify the “optimal” tax in the presence of the Z sector.



Intermediate Goods

Home Page

Title Page



Page 9 of 17

Go Back

Full Screen

Close

Quit

5. Endogenous Labor Supply

Tax policy can change dramatically when labor-supply is elastic. We allow consumers a labor-liesure choice by adding an additional \$prod: activity:

```
$prod:LS
O:PLS  Q:100
I:PL   Q:100 A:CONS T:TL
```

This sets up a “labor-supply” activity, which converts liesure time (PL) into labor supplied to the market (PLS).

An *ad-valorem* tax is applied liesure supplied to the market at the rate TL. This tax represents direct labor income taxes.

We can double the labor endowment, which gives the consumer an additional 100 units of liesure:

Markets	Production Sectors				T	Consumers CONS
	A	B	W			
PX	100		-100			
PY		100	-100			
PW			300			-300
PLS	-40	-60		100		
PL			-100	-100		200
PK	-60	-40				100



Intermediate Goods

Home Page

Title Page



Page 10 of 17

Go Back

Full Screen

Close

Quit

Optimal taxation centers around the presence of un-taxed good, we will carry out some exercises to determine when the Ramsey-rule holds, and when it does not.

5.1. Exercises:

1. Design a new MPSGE model based upon the SAM above.
2. Include a separate nesting in the consumption block for consumption goods, with an elasticity of substitution of one. Set the top-level elasticity equal to $1/2$. Verify that the model replicates the benchmark data.
3. **Tax Analysis** Compare the relative welfare effects of raising \$25 in tax revenues from two sources: direct labor taxes **TL** and a sales tax: **STX**. Which tax is more efficient?
4. **Welfare vs. Consumption** Compute the real value of consumption:

$$VC = \frac{p_x X \cdot \bar{X} + p_y Y \cdot \bar{Y}}{p_x^{1/2} p_y^{1/2} \cdot \bar{C}}$$

Then compare relative value of (after-tax) consumption with relative welfare, which includes leisure. In general, consumption-only measures tend to *overstate* the welfare loss of a tax, and *understate* the benefit of removing a distortionary labor tax. This notion relates to the *Double-Dividend* literature.



Intermediate Goods

Home Page

Title Page



Page 11 of 17

Go Back

Full Screen

Close

Quit

6. Informal Labor Market

In the static model for Colombia, `mcfmodel`, there exist two types of labor: formal and informal. We can use the M1 model framework to focus upon this assumption specifically, which often aids understanding.

MPSGE makes it easy to incorporate informal labor, the labor-liesure choice is simply extended to include two outputs, PLSI and PLSF.

```
$PROD:LS  T:ETA
      O:PLSI      Q:50
      O:PLSF      Q:50  A:CONS  T:TL
      I:PL        Q:100
```

From the Colombian 1996 dataset, we know that some sectors utilize informal labor intensively. Agriculture is one such sector. Public sector utilities (electricity, communication) use mostly formal labor.

How easily workers can move between labor markets is determined by η , the elasticity of transformation for LS.

6.1. Exercises:

1. Extend the *endogenous labor supply* model to include an informal labor sector. Make the Y sector use informal labor intensively (50 units in the benchmark). Verify that the model still calibrates when the *iterlim* is set to zero.
2. Compare the impact of a 25% direct labor tax upon welfare and wages when $\eta = 0$, $\eta = 0.5$, $\eta = 1.5$, $\eta = 6$. This exercise demonstrates the importance of *sensitivity analysis*.



Intermediate Goods

Home Page

Title Page



Page 12 of 17

Go Back

Full Screen

Close

Quit

7. Multiple Households

Lobbyists and policy-makers are typically more interested in the *distributional* impact than the *efficiency* of a policy change.

We can identify the redistribution of income by including *multiple households*. This is a straightforward extension of the standard model.

The following SAM shows consumption patterns and endowments for each household:

Two household: differ in preferences and in endowments

Markets	Production Sectors				Consumers	
	X	Y	WA	WB	A	B
PX	100		-40	-60		
PY		100	-60	-40		
PWA			100		-100	
PWB				100		-100
PL	-25	-75			90	10
PK	-75	-25			10	90

A typical tax will have three distinct effects upon each household:

- Re-distribution of income via taxes,
- Price impact upon different preferences,
- Factor price impact upon different factor endowments (labor and capital)



Intermediate Goods

Home Page

Title Page



Page 13 of 17

Go Back

Full Screen

Close

Quit

7.1. Exercises:

1. Formulate the multiple-household model using the SAM above.
2. Apply a 20% tax to sector X inputs and redistribute the taxes evenly between A and B. Identify winners and losers and why.
3. Is there a redistribution of taxes where both consumers are worse off (as if they were a single Representative consumer)?
4. What happens to the factor-price effect when the elasticity of substitution in W_A, W_B is increased?



Intermediate Goods

[Home Page](#)

[Title Page](#)



Page 14 of 17

[Go Back](#)

[Full Screen](#)

[Close](#)

[Quit](#)

8. Stone-Geary Preferences

Most budget studies indicate that preferences are not homogeneous. In particular, low-income households tend to spend a higher portion of their budget on basic goods (like food) than high-income households.

To address this issue, the Linear Expenditure System was created. A typical form for this function is:

$$U(X, Y) = (X - X^*)^\alpha Y^{1-\alpha}$$

Where X^* is the “minimum consumption requirement” of X before Utility is actually positive.

The corresponding uncompensated demand functions would be:

$$X = X^* + \frac{\alpha(1 - p_x X^*)}{p_x}$$

$$Y = \frac{(1 - \alpha)(1 - p_x X^*)}{p_y}$$

In the first equation, demand for X is the *minimum requirement*, X^* , plus the remaining budget split up according to prices and the share value, α .

Similarly Y represents the remaining share of the budget split up according to $(1 - \alpha)$. The budget share equation for LES is:

$$\frac{p_x X}{I} = \frac{\alpha I + (1 - \alpha)p_x X^*}{I}$$



Intermediate Goods

Home Page

Title Page



Page 15 of 17

Go Back

Full Screen

Close

Quit

and the income elasticity of demand for X is:

$$\frac{I}{X} \frac{\partial X}{\partial I} = \frac{\alpha I}{\alpha I + (1 - \alpha)p_x X^*}$$

As income increases, the budget share approaches α and the income elasticity approaches unity.

8.1. Calibration

We want to calibrate the M1 SAM to incorporate an LES function with an income elasticity of demand of 0.75. We know that the budget share from the data is: $\frac{p_x X}{I} = 1/2$ and we set the elasticity figure to $\frac{I}{X} \frac{\partial X}{\partial I} = 3/4$, then solve for α . We get $\alpha = 3/8$.

If $\alpha = 3/8$, then we know from either equation that $X^* = 40$. This minimum consumption is included into MPSGE as a *negative endowment*.

The remaining consumption bundle can now be incorporated into the consumer's welfare function, adjusting for the negative X endowment in the `$demand:` block:

```
$PROD:W s:1
      O:PW      Q:160
      I:PX      Q: 60
      I:PY      Q:100
```

8.2. Exercises:

1. Rewrite the standard model to incorporate Stone-Geary (LES) preferences.



Intermediate Goods

Home Page

Title Page



Page 16 of 17

Go Back

Full Screen

Close

Quit

2. Verify that as income rises, consumption shifts toward Y .



Intermediate Goods

Home Page

Title Page



Page 17 of 17

Go Back

Full Screen

Close

Quit