CONTRIBUTIONS TO A SOURCEBOOK OF HELPFUL HINTS FOR TRAINING FUTURE PRACTITIONERS OF DEVELOPMENT ECONOMICS AND POLICY

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June 2007

Introductory Note: The immediate purpose of this paper is to serve as background material for participants in a conference for improving economics training in and for developing countries. We are inviting each of these authors to contribute his or her own list of vignettes each dealing with a point that the author feels is overlooked or short-changed in most ongoing training programs, and which could usefully replace less-relevant materials that are actually included in such programs.

I do not apologize for the somewhat technical tone of these notes, because the function of the training programs that we are talking about is to produce serious professional economists who have genuine command of the basic tools of their trade.

I have chosen these vignettes from public finance, with a sort of micro orientation. In another piece that will also be distributed to participants "Can We Identify the Basic Tools...?" I give examples with a more macro orientation.

1. Income and Substitution Effects

Real income is operationally defined as a Laspeyres index

$$y = \sum_i P_i^o X_i .$$

**This paper was prepared under the auspices of USAID.

In two dimensions (i = 1, 2) this breaks down to a set of parallel diagonal lines between the X_1 and X_2 axes. Pick any two points A and B on such a grid. They will be characterized by their "own" sets of relative prices, P_a and P_b, and by their own indexes of real income, y_a and y_b. Through point A there will be an income-expansion path -- the locus of all points of potential demand equilibrium under relative prices P_a -- label that path E_a. Similarly there will be through point B an income expansion path E_b, characterized by potential demand at prices P_b. We now define two additional points A' and B'. A' is the intersection of y_b with E_a, and B' is the intersection of y_a with E_b. We then have two breakdowns into income and substitution effects -- one, an income effect move along E_a from A to A', and a substitution effect move along y_b from A' to B, and the other, a substitution effect move along y_a from A to B', together with an income effect move from B' to B. This exposition can be shown in a simple two-dimensional graph, but extends easily to n commodities (i = 1, …n).

2. Compensated and Uncompensated Elasticities

Consider that the move from A to B is the consequence of a change in the price of X_1, other prices and money income staying the same. The elasticity measure obtained from the move will be η^u_{11}, uncompensated own-price elasticity. The move from A to B' will encompass an income effect equal to m_1 the (marginal propensity to spend on X_1) times the change in real income [$-X_1 \Delta P_1$, divided by the price (P_1) of the good in question]. So the change in X_1 due to the income effect is equal to $-m_1 X_1 (\Delta P_1/P_1)$. To get the corresponding percentage change in X_1, we divide by X_1 obtaining $-m_1 (\Delta P_1/P_1)$. Thus we have the following relationship between the compensated and uncompensated own-price elasticities of demand:

$$\eta_{ii}^{u} = \eta_{ii}^{c} - m_i .$$

The corresponding relationship for cross-elasticities is

$$\eta_{ij}^{u} = \eta_{ij}^{c} - \sigma_i a_j ,$$

where a_j is the average propensity to spend on X_j and σ_i is the income elasticity of demand for good i. [There is no contradiction between the two expressions above, since $\sigma_i = m_i/a_i$.]

At this early point in a student's training, it is worth while to drive home that there can hardly be an important difference between compensated and uncompensated elasticities for most items for which elasticities are measured, since their marginal and average propensities are likely to be very small. Important differences can enter in cases like the demand for tradables and nontradables, possibly in housing, and certainly in the case of the demand for leisure (= supply of labor). In the latter case, the compensated and uncompensated statistics of labor supply are linked as follows:

$$\varepsilon^{u} = \varepsilon^{c} - m_{\ell},$$

Where m_{ℓ} is the marginal propensity to consume leisure, defined as the fraction of an increment to real income that is taken out in the form of leisure. Historically, ε^{u} has been negative. This limits how much greater than zero ε^{c} can have been. Plausible numbers might be $\varepsilon^{u} = -.15$, $\varepsilon^{c} = +.10$; $m_{\ell} = .25$.

3. <u>More on Demand and Supply</u>

Many economists somehow have been brought up to think that the uncompensated elasticity is the "natural" one, and that the compensated elasticity is sort of artificial, requiring some sort of hypothetical, extraneous act of compensation to take place. Actually most econometric work on demand has real income as one of the main explanatory variables. Hence at least in principle, most measured price elasticities are "compensated".

On a related matter, when economists examine the likely effects of policy interventions like taxes, subsidies, agricultural programs and the like, the question again arises of what to hold constant in the analysis. One key fact is pretty clear -- by imposing a tax, granting a subsidy, or supporting a product's price, the government is doing nothing to alter the underlying set of resource constraints under which the economy operates. A resource-constrained demand function is a close relative of the standard "compensated" demand function, but is hard to bring down to the individual level.

A very useful way to think of resource-constrained demand and supply functions is to define these functions "on the instrument" whose effects we are analyzing.

To conceptualize such functions, think of $X_1^0 = 100$ and $P_1^0 = 1.0$ as the equilibrium quantity and real price that would prevail for X_1 in the absence of any tax or subsidy. Now consider a tax of .10 on that good. That might lead to $X_1 = 90$, demand price $P_1^d = 1.05$ and supply price $P_1^s = 0.95$. A tax of .20 might similarly lead to $P_1^d = 1.10$, $P_1^s = 0.90$ and $X_1 = 80$. A subsidy of .20 could produce $P_1^s = 1.10$, $P_1^d = 0.90$ and $X_1 = 120$. An exercise like this implicitly uses the economy itself as our computer, and traces out loci of demand price, supply price and quantity as we vary the rate of tax or subsidy in X_1. Using these demand and supply functions it is easy to trace out the quantity, price and efficiency cost consequences of taxes, subsidies and other policy interventions.

4. A Resource-Constrained System

I will present this system here for the case of generalized constant costs (= infinite elasticities of supply). One need not think of them as prevailing over the entire range of the variables, but only over the relevant range over which those variables will move, as one introduces taxes, subsidies, and other instruments of policy. I will deal here only with taxes and with subsidies (conceived as negative taxes). General equilibrium constraints are observed by assuming either:

a) tax moneys are all returned as lump sum subsidies, or

b) the government's demand functions for spending tax revenues are similar to those of the public, or

c) the government buys a specified vector of goods and services, and finances these outlays by the specified taxes, returning excess receipts via neutral subsidies, or meeting revenue shortfalls via additional neutral taxes.

All of these alternatives allow us to work with a demand system for the economy as a whole. It is this system that we now explore.

Using S_{ij} to represent $\partial X_i^d / \partial P_j^d$. We have, first of all, from the resource constraint $\sum_i X_i P_i^s = 0$. Since the P_i^s are all constant, it follows that $\sum_i P_i^s S_{ij} T_j = 0$. That is, imposing any one tax causes resources to shift around, but does not change the overall resource constraint. The above equation gives us one adding-up property of compensated demand functions, i.e., $\sum_i P_i^s S_{ij} = 0$.

Another adding-up property comes from the idea that a neutral system of taxes should not lead to any change in equilibrium quantities. Thus a fully general, uniform tax on all relevant flow demands (including leisure) should leave all equilibrium quantities unchanged. Thus, $\sum_i S_{ij} T_j = 0$ when the T_j all obey $T_j = \tau * P_j^s$. This leads to the adding up property $\sum_i S_{ij} P_j^s = 0$.

It is interesting to note that the standard symmetry property of substitution terms $= (\partial X_i^d / \partial P_j) = (\partial X_j^d / \partial P_i)$, which in our notation is $S_{ij} = S_{ji}$ eliminates any possible contradiction between the above two adding-up properties, derived from different mental experiments.

5. An Intuitive Defense of the Symmetry Property

To see how the symmetry property works one has to think of dividing the substitution "away from" X_1 into a bunch of component parts as implied by the first adding-up exercise, i.e., $P_1S_{11}T_1 = -P_2S_{21}T_1 - P_3S_{31}T_1 - P_4S_{41}T_1,..., - P_nS_{n1}T_1$.

$P_3S_{31}T_1$ is the amount of "purchasing power" that is shifted from X_1 to X_3 when the price of X_1 is raised by T_1. This is equal to $P_3P_1S_{31}\tau$ when $(T_1/P_1) = \tau$.

By a similar argument $P_1S_{13}T_3$ is the amount of purchasing power shifted from X_3 to X_1 when the price of X_3 is raised by T_3. This becomes $P_1P_3S_{13}\tau$ when $(T_3/P_3) = \tau$. Thus, the symmetry property means that a tax that raises the prices of X_1 and X_3 by the same percentage engenders no substitution between them, only between each of them and all other goods (i.e., the purchasing power that shifts from X_1 to X_3 when the tax τ is imposed on X_1, is shifted back from X_3 to X_1 when the same percentage tax is imposed on X_3). This principle is the foundation of the theory of composite commodities, well explained by J.R. Hicks long ago in Value and Capital. But this is also what underlies the symmetry property. The symmetry property is often motivated as necessarily following, so long as the underlying utility function fulfills the "integrability condition". Our justification does not contradict this; it merely puts economic meat on its more formalistic bones.

6. Tax Analysis in a General Equilibrium Setting

The basic rule for measuring efficiency gains and losses takes competitive demand price as the measure of benefit and competitive supply price (or marginal resource cost) as the measure of cost. If we define D_i as $(P_i^d - P_i^s)$ and z as representing the measure we are analyzing, with z being imposed at the level z^*, the general equilibrium efficiency effects of z^* are measured by

$$\Delta w = \int_{z=0}^{z^*} \sum_i D_i \frac{\partial X_i}{\partial z} dz.$$

This allows for the D_i's to change as z changes. Thus when the only distortion is a single tax on X_i the above measure leads to the standard triangle between the supply and demand curves -- with linear supply and demand $\Delta W = \frac{1}{2} T_i \Delta X_i$.

In general, the distortions in "other" markets do not change as a new distortion is introduced. Thus introducing T_3 when we already have T_1 and T_2 leads to $1/2\, T_3 \Delta X_3$, in the directly affected market plus $T_1 \Delta X_1$ and $T_2 \Delta X_2$ in the markets with pre-existing taxes already in place.

If we start from scratch, with infinitely elastic supplies, and with W as our measure of welfare, we get

Step 1: Impose T_1 -- $\Delta W = \frac{1}{2} S_{11} T_1^2$.

Step 2: Add T_2 -- additional $\Delta W = \frac{1}{2} S_{22} T_2^2 + T_1 S_{12} T_2$.

<u>Step 3</u>: Add T_3 -- additional $\Delta W = \frac{1}{2} S_{33} T_3^2 + T_1 S_{13} T_3 + T_2 S_{23} T_3$.

Overall: $\Delta W = \frac{1}{2} S_{11} T_1^2 + \frac{1}{2} S_{22} T_2^2 + \frac{1}{2} S_{33} T_3^2 + T_1 S_{12} T_2 + T_1 S_{13} T_3 + T_2 S_{23} T_3$.

Now, using the symmetry property derived earlier, we have

$$T_1 S_{12} T_2 = \frac{1}{2} T_1 S_{12} T_2 + \frac{1}{2} T_2 S_{21} T_1$$

$$T_1 S_{13} T_3 = \frac{1}{2} T_1 S_{13} T_3 + \frac{1}{2} T_3 S_{31} T_1$$

$$T_2 S_{23} T_3 = \frac{1}{2} T_2 S_{23} T_3 + \frac{1}{2} T_3 S_{32} T_2$$

Joining these six terms to the three terms of the form $\frac{1}{2} S_{ii} T_i^2$, we get, for the efficiency effects of all 3 taxes taken together

a) $$\Delta W = \frac{1}{2} \sum_i \sum_j S_{ij} T_i T_j \quad \text{(quadratic form).}$$

Now, recognizing that

$$\Delta X_i = \sum_j S_{ij} Tj,$$

and with ΔX_i standing for how much X_i has changed over all three steps, we have

b) $$\Delta W = \frac{1}{2} \sum_i T_i \Delta X_i \quad \text{(generalized triangle)}$$

Also, with a little more work using the symmetry and adding-up properties, one can show that

c) $$\Delta W = \frac{1}{2} \sum_i \sum_{j<i} P_i P_j S_{ij} (\tau_i - \tau_j)^2, \quad \text{(pair wise breakdown)}$$

where $\tau_i = T_i / P_i$.

It is very important to recognize that all three expressions a), b), and c) say the same thing mathematically. But looking at all three adds to our economic understanding and (at times more importantly) can save us a lot of time and trouble.

For our economic understanding the idea of a generalized triangle is quite appealing. The way to think of it is that we are imposing "at the same time" a whole vector of taxes $T_1^*, T_2^*, ..., T_n^*$. But instead of imposing them in sequence, we do so "radially", starting with, say, 1/10 of each tax, then zipping it up to 2/10, then to 3/10, etc., until we finally reach 100%. In terms of our basic distortion formula we can write

$$\Delta W = \int_{\lambda=0}^{1} \sum_i \lambda T_i^* \frac{\partial X_i}{\partial \lambda} d\lambda,$$

which for the linear case reduces to

$$\Delta W = \frac{1}{2} \sum_i T_i^* \Delta X_i .$$

This case obviously leads one to think of triangles, one for each commodity. When there is only one tax on only one good, this is just a standard, straightforward tax triangle. And it is pretty much the same if we think of taxes as only a few (out of many) items. But if we think of taxes spanning <u>all</u> goods, then necessarily half of the length of the bases of the triangles has to be positive, and their contribution to the overall change in welfare will also be positive; though necessarily outweighed by the other triangles in the series with a negative ΔX_i.

Thinking of the pairwise breakdown of efficiency cost leads us to recognize that substitution is fundamentally a pairwise phenomenon and that movement along, say, the demand curve for apples can be expressed in terms of substitution of apples for other fruits, of apples for foods other than fruits, of apples for non-food tradables, of apples for nontradables, of apples for leisure.

Looking at the quadratic form expression for ΔW, the first insight that comes from it is its resemblance to the quadratic form that represents the second-order condition for a maximum. In economic terms, if we start from an initially undistorted situation, we have no way to go but <u>down</u>, or at best stay level. This says that

$$\Delta W = \frac{1}{2}\sum_i \sum_j S_{ij}T_iT_j \leq 0.$$

On the practical side, suppose we are working with a computable general equilibrium model, with a number of taxed industries and sectors. What is easier than to find the equilibrium of this model with zero distortions, then recompute to get the solution with all our taxes, and finally simply take ΔX_i as the difference between these two solutions, to get a generalized-triangle measure of the total change in efficiency going from the undistorted to the distorted equilibrium, equal to:

$$\Delta W = \sum_i T_i \Delta X_i \, .$$

The quadratic form is also useful for dealing with all sorts of "second-best" or even "nth best" problems. One favorite of tax specialists is the so-called Ramsey problem -- minimize the efficiency cost of raising an amount R of revenue by imposing taxes $T_1, T_2, ..., T_k$ on k goods, which represent only a subset of the entire range of goods going from X_1 to X_n $(n > k)$. The dual of this problem, which of course leads to the same solution, is to maximize the revenue to be obtained from $T_1, T_2, ..., T_k$, while keeping efficiency cost constant. (An interesting insight from this dual expression is its similarity to the problem of a discriminatory monopolist selling a product in k separate markets).

7. <u>We Get to Choose Our Own Tools for Each Problem</u>

We economists should never forget that it is we who constructed our tool kit, for the purpose of helping us in our various tasks. Hence we should always be ready to jump from one variant to another, as we go from task to task. The three variants of the expression for ΔW are equivalent, but the generalized triangle is the easiest way to measure efficiency costs in a computable general equilibrium exercise, the pairwise breakdown is the easiest way to show the neutrality of a uniform percentage tax that is truly general, and the quadratic form is the most effective way to find second-best solutions.

The lesson carries over to the choice of <u>numeraires</u> in which to couch our analysis or carry out our original exercises. For example, in a fixed exchange rate system, looking over time, the natural numeraire is $E\overline{P}*$, the nominal exchange rate E times the world price of tradables $\overline{P}*$. [Note that this numeraire is independent of the choice of foreign currency in which E is expressed. If E is pesos per dollar, then $\overline{P}*$ must naturally deal with dollar prices of tradables. If we change to E' (= pesos/Yen) then obviously the corresponding $\overline{P}*'$ must reflect the yen price of tradables. Thus E' = E*($/¥) and $\overline{P}^{*'} = \overline{P}^{*}$(¥/$). Hence $E'\overline{P}^{*'} \equiv E\overline{P}^{*}$, so long as we are dealing with convertible currencies.]

When we carry out policy analyses, we nearly always will be taking the time path of $\overline{P}*$ as given, so our numeraire is proportional to E. This helps us see that, if we start from a position of equilibrium in the real economy, a simple change of the nominal exchange rate will typically lead to the same real equilibrium being restored, but at a higher level of nominal prices.

On the other hand, when one sets up a problem in the form of what I call a Cobb-Douglas world (product demands derived from a Cobb-Douglas utility function, factor demands from Cobb-Douglas production functions), the natural numeraire is total expenditure. If we call total expenditure Z, then the product demand functions will be $X_iP_i = a_iZ$ and the demand for factor i in industry j will be $F_{ij} = b_{ij}a_jZ$. The total demand for factor i will be $\sum_j b_{ij}a_jZ$. Since this does not change if we impose a factor-income tax (e.g., corporation income tax) on factor i, it follows quite directly that the incidence of such a tax will fall on factor i alone -- a result that is readily found using Z as the numeraire, but much harder to find if another numeraire is chosen.