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9. Appendix: CALCULATION OF MCF IN CGE MODELS

The calculation of the Marginal Cost of Funds (MCF) in Computable General Equilibrium (CGE) models is done in a three step procedure, since as it is a 'compensated equilibrium' concept, it does not fall out of a CGE model in a single step. (See Anderson and Martin, 1995 for more details, including reasons for preferring the compensated to the uncompensated version of MCF).

9.1. Calculation

The first step is to run the CGE experiment which calculates the rate of change of money metric utility with respect to an external transfer offset by a change in the distortionary taxes of interest. (In the text these are tariffs and domestic consumption taxes.) For the first step, perform the following operations:

- Transfer an *external* exogenous amount $d\beta$ into the government budget,
- offset by an endogenous proportionate change in the tax vector of interest; e.g., $(p-p^*)d\alpha$, where $d\alpha$ is the endogenous scalar; and
- calculate the change in money metric utility which arises from this experiment ($E_u du$ and $d\alpha$ are endogenous, the government budget constraint and the private budget constraint are the two equations which determine them). This is denoted $E_u du/d\beta(1)$. It is the uncompensated marginal cost of funds for the taxes of interest.

The second step is to run the CGE experiment which calculates the shadow price of foreign exchange, also called the fiscal multiplier by Anderson and Martin (1995).

- Transfer the same exogenous external amount $d\beta$ into the government budget,
- offset by a lump sum transfer $d\rho$ from the government to the private sector.
- Calculate the rate of change in money metric utility which results. This value is the shadow price of foreign exchange for experiment 2.

The third step is to calculate MCF^p using the results of the first two steps. Based on the simple case of the text, this involves dividing the result of the first experiment by the result of the second. Unfortunately, a complicating factor is that some CGE models (including the Korean model of the text) apply a tax rate to external transfers. Call this rate τ, so that a proportion τ of the external transfer goes to the government, the proportion $(1-\tau)$ going to the private sector. Also, some CGE models have savings as a part of intertemporal structure. These complications necessitate a bit more elaborate derivation.

9.2. Derivation

The derivation of the MCF and shadow price of foreign exchange μ functions is based on the 2 equation system of the government and private sector budget constraints:

(A.1) $\tau\beta + (p-p^*)' E_p + (q-q^*)' E_q - \pi G - \rho = 0$ government constraint,

(A.2) $E - (1-s)(1-\tau)\beta - (1-s)\rho = 0$ private constraint,

where $E(p,q,G,u)$ is the private net expenditure on private goods, G is the government good obtained at external price π (for simplicity), ρ is the transfer from the government to the private sector, β is the external transfer, τ is the tax rate on transfers, p is a domestic price vector for the class of goods we are interested in for MCF purposes and q is a domestic price vector for some other class of goods subject to distortions. For a model with savings, there is also a macroeconomic balance equation $s[(1-\tau)\beta + \rho]$ = Investment, where Investment causes demand links to the general equilibrium structure which need not be detailed here.

9.2.1.MCF Experiment

The domestic price vector p will change according to $dp = (p-p^*)d\alpha$, where α is a scalar. $d\beta$ is the exogenous shift parameter, and $d\alpha$ and du are endogenous changes which satisfy the two constraints in changes. ρ, G, q and τ are constant. First solve first from the government budget constraint for $d\alpha/d\beta$:

$$\text{(A.3)}\quad \frac{d\alpha}{d\beta} = \frac{-\tau - \{(p-p^*)' E_{pu} + (q-q^*)' E_{qu}\} du/d\beta}{(p-p^*)' E_p + (p-p^*)' E_{pp}(p-p^*) + (q-q^*)' E_{qp}(p-p^*)}.$$

Substituting into the differential of the private budget constraint:

$$\text{(A.4)}\quad \{1 - MCF^p[(p-p^*)' E_{pu}/E_u + (q-q^*)' E_{qu}/E_u]\} E_u du = (1-\tau)(1-s) + \tau MCF^p$$

where

$$MCF^p = \frac{E_p'(p-p^*)}{E_p'(p-p^*) + (p-p^*)' E_{pp}(p-p^*) + (q-q^*)' E_{qp}(p-p^*)}.$$

Solving for the money metric utility rate of change:

$$\text{(A.5)}\quad E_u \frac{du}{d\beta}(1) = \mu(1-\tau)(1-s) + \mu\tau MCF^p,$$

where μ is the inverse of the coefficient multiplying $E_u du$ on the left hand side of (A.4):

$$\text{(A.6)}\quad \mu = \frac{1}{\{1 - MCF^p[(p-p^*)' E_{pu}/E_u + (q-q^*)' E_{qu}/E_u]\}}.$$

With τ equal to one, equation (A.5) gives the money metric or uncompensated version of the marginal cost of funds. The left hand side of (A.5) is calculated from a CGE model.

9.2.2.Shadow Price of Foreign Exchange Experiment

The redistribution ρ changes endogenously along with u in response to an exogenous change in the external transfer β, to satisfy the two constraints in changes. The variables p,G, τ and q are constant. Solving the government budget constraint for $d\rho/d\beta$:

$$\frac{d\rho}{d\beta} = \tau + [(p-p^*)' E_{pu} + (q-q^*)' E_{qu}] du/d\beta.$$

Substituting into the differential of the private budget constraint:

$$\{1-(1-s)[(p-p^*)' E_p + (q-q^*)' E_q]\} E_u du/d\beta = (1-s)[(1-\tau)+\tau] = 1-s.$$

Therefore, solving for the rate of change in money metric utility:

$$\text{(A.7)}\quad E_u \frac{du}{d\beta}(2) = \frac{1-s}{\{1-(1-s)[(p-p^*)' E_p + (q-q^*)' E_q]\}} = \mu(2).$$

The left hand side of (A.7) is calculated from the CGE experiment. Note that the shadow price of foreign exchange in this experiment is not the same as that for the MCF experiment, $\mu(2)$ is not equal to μ. The relation between them is:

$$\text{(A.8)}\quad \frac{1}{\mu} = 1 + \left(\frac{1}{\mu(2)} - \frac{1}{1-s}\right) MCF^p.$$

9.2.3.Solving for MCF

Divide equation (A.5) through by μ:

$$\frac{E_u \frac{du}{d\beta}(1)}{\mu} = (1-s)(1-\tau) + \tau MCF^p.$$

Then use equation (A.8) to substitute for *1/μ* and solve for MCF^p:

$$\text{(A.9)} \quad MCF^p = \frac{E_u \frac{du}{d\beta}(1) - (1-\tau)(1-s)}{\tau + E_u \frac{du}{d\beta}(1)\left(\frac{1}{1-s} - \frac{1}{\mu(2)}\right)}.$$

The right hand side of equation (A.9) is in terms of observables and the two calculated values from the two CGE experiments.

FIGURES AVAILABLE ON REQUEST FROM THE AUTHOR

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