Open Economy Macro, the World Bank, and the Doha Debate

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September 2005

Main Points

- Huge literature on the effects of trade liberalization in the WTO rounds, with a big focus on agriculture.
- Lots of models, which in effect do open economy macro since they are “global”.
- They basically forget the ancient distinction between the “elasticities” and “absorption” approaches to the balance of payments, ignoring the latter and obsessing on the former (the detailed specifications are *really* Gothic).

Outline

- So what we want to do is set up a proper demonstration model to sort things out. The key issue is model “closure” or the causal structure of the system.
- Project is not complete, but is presented here in hopes of feedback.
- And apologies for setting up the system in strictly neoclassical terms, but that’s what the literature does so we have to do the same!
- Start with a review of the debate, then model specifications in terms of a SAM (courtesy Wynne Godley), then data, and ideas about results.

The Doha Process – Overview

- 4th WTO Ministerial Conference in Doha, Qatar, November 2001 sets the agenda
  - An agreement is made on a working program and timeline on Trade in Agriculture, Trade in Services and the “Singapore Issues”
  - Singapore Issues (1996): Investment, competition policy, government procurement, trade facilitation

The Doha Process – Overview

- 5th WTO Ministerial Conference in Cancun, Mexico, September 2003 fails
  - Singapore Issues: Especially *investment* and *competition policy* are seen by developing countries as potential limits imposed on their range of policy options
  - Agriculture: Despite general agreement on the three pillars *market access, removal of export subsidies* and *reductions of domestic support* views on the degree of change differ strongly. The *Cotton Initiative*, launched by Benin, Burkina Faso, Chad and Mali in April 2003, exemplifies the rift between developing and developed countries.
  - Special and Differential Treatment (SDT): Least Developed Countries (LDC's) oppose removal.
  - The Singapore issues are the key to failure.

The Doha Process – Overview

- The *July 2004 Framework* picks up the pieces
  - January: U.S. trade representative Bob Zoellick circulates a discussion paper amongst ministers where he suggests to focus on agriculture, industrial goods and services
  - May: EU commissioners Pascal Lamy and Franz Fischler propose to drop the more controversial Singapore Issues and indicate room for compromise with regard to the European stance on agricultural support.
  - Meetings in Geneva between March and July
  - August 2004: Agreement is found on a *Framework for Establishing Modalities in Agriculture*
    - Balances between the three agricultural related pillars and other issues are not foreclosed
    - *Substantial reductions* in domestic support are mentioned
    - Developing countries concerns are specifically addressed: Development, Non-trade concerns, Cotton, Special and Differential Treatment.

Doha: Focus on Agriculture

- Export Subsidies: Elimination
  - Removal of all agricultural export subsidies and similar support such as export credits (in the U.S.)
- Domestic Support:
  - Green Box: Non-distortionary domestic support such as research and development programmes do not require reduction commitments, but are subject to clarification.
  - Blue Box: Support measures aimed at limiting production are supposed to be capped.
  - Amber Box: Distortionary domestic support such as price support are to be reduced according to the following principals:
    - Tiered formula for substantial reductions in the *Aggregate Measure of Support (AMS)*
    - Special and Differential Treatment for developing countries.

Doha: Focus on Agriculture

- Market Access: Substantial improvements in market access through tariff removal:
  - Flexibility and Generality: A tiered formula is proposed to reduce *all* tariffs.
  - Harmonization and Progressivity: The higher the tariff, the higher the reduction in bound rates.
  - Sensitivity: Some sensitive products can be treated outside the tiered formula
  - Special and Differential Treatment (SDT): SDT is recognized as an integral part of the negotiations for developing countries. Rural development, food security, livelihood security needs are brought forth as reasons for SDT with regard to tariff removal and other policies.
  - LDC's: Least Developed Countries are not required to reduce tariffs.

- *Next Ministerial Meeting: December 2005, Hong Kong*

Agriculture: Stylized Facts

- Declining share of agricultural output in total output, in developed as well as in developing countries. Agriculture made up 1.9%, 9% and 25% in GDP in High, Middle and Low Income countries, in 2001, down from 4%, 16%, 33% in 1980, respectively. (Source: World Development Indicators)
- Despite the negative trend in agricultural share growth, sectoral employment shares differ widely between developed and developing countries. Up to 70% of the labor force is occupied in agriculture in developing countries, vs. 5% in developed countries.
- On average, non-farm incomes are higher than farm incomes in developing countries, whereas the opposite is true in developed countries – farm income is comparatively high due to support measures.

Agriculture: Stylized Facts

- The share of trade in agriculture diminishes, mirroring the overall structural change of the world economy.
- The composition of developing countries' exports in agriculture changed significantly: Fruits, vegetables and seafood replace traditional agricultural exports.
- Average applied tariff rates are higher for agricultural products than for manufactures and other merchandise.
- Producer support in OECD countries was about 230 Billion U.S. Dollars in 2001, which amount to 46% of production value at world prices. (The key terms here are *Producer Support Estimate (PSE)*, *Market Price Support* and *Total Support Estimate*.)
- Traditionally high producer support in developed countries for cotton, beef, rice (700% of world prices in Japan!), sugar and banana are the most controversial.

The Bank's simulations and policy recommendations

- Global welfare gains:
  - Total trade liberalization and subsidy removal is projected to result in about 300 Billion U.S. Dollars gained in global welfare, excluding potential productivity effects.
- Agricultural tariffs take center-stage:
  - Agricultural tariffs are said to be crucial to achieve these welfare gains. Despite the small share in global output and diminishing importance in world trade, the World Bank's calculations show reductions in these tariffs account for 93% (!) of all welfare gains, with export subsidies and domestic support accounting for the remainder.
- Agricultural tariffs *in developing countries* play main role:
  - Tariff removal between developing countries is said to be critical for success, because applied tariff rates are highest amongst developing countries and a large (and inreasing) share of trade takes place between them.
  - About 52% of the welfare gains in developing countries after agricultural trade policy reforms are due to *their own* tariff and subsidy removal.

The Bank's simulations and policy recommendations

- Overall, *large* cuts are necessary to produce welfare gains.
  - Total bound AMS – domestic producer support – requires cuts of about 75% to reduce actual support.
  - Bound tariff rates are substantially higher than applied tariff rates.
  - Exemption of sensitive (agricultural) products in the North and South has strong implications for liberalization outcomes:

    "Even if only 2 percent of HS6 agricultural tariff lines in developed countries are classified as sensitive (and 4 percent in developing countries, to incorporate also their "Special Products" demand), and are thereby subject to just a 15 percent tariff cut (as a substitute for the TRQ expansion mentioned in the Framework Agreement), the welfare gains from global agricultural reform would shrink by three-quarters." (WB, Trade Note, June 2005)
- Effects on Poverty:
  - Some LDC's are projected to lose, due to adverse terms of trade effects.
  - Rural areas in developing countries are supposed to gain, as returns to labor in agriculture increase due to tariff removal, even though the overall effects on poverty are admitted to be small.

Our model: The SAM

- Discuss a modeling framework to address these issues.
- We present a 2-country SAM to illustrate how these machines are set up. Some of the main characteristics are:
  - Disaggregation of supply into domestic goods *PX* and imports $P_M E^*$ with price P=(1+t)eZ* with *t* = tariff rate, *e* = exchange rate, and Z* = foreign aggregate price.
  - Private income = value-added *V.*
  - Government income from direct taxes *T* and tariffs .
  - Imports and domestic goods form a domestic “Armington” aggregate *A* with price *Z.* This aggregate meets demands for consumption, government, investment, and exports.

Armington

- What is “Armington”?
  - Paul Armington’s original article “A Theory of Demand for Products Distinguished by Place of Production,” IMF Staff Papers, dates back to 1969.
  - The Armington-trade-specification is a way to model trade in a multi-country, multi-commodity setting such that *bang-bang* solutions are excluded. The *neoclassical bang-bang* would be that households in any country demand only the good with the lowest price, so that good i produced in country j is the only variety bought anywhere on the globe. Transportation and information costs as well as heterogeneity and local/regional markets make this an undesirable, unrealistic outcome.

Armington

- How does it work?
  - CES-Import Function: Constructing a CES-aggregator demand function for domestically produced and imported goods guarantees that the demand curves for those imports are downward sloping.
  - CET-Export Function: Analogous, domestically produced goods for the home market and for exports are defined in a CET-supply function.
  - The elasticity of substitution (or transformation) between domestic “cars” and imported “cars” determines the degree to which the demand curves for the two coincide.
  - Usually, “the standard model specification adds up Armington demand across domestic agents and the Armington decomposition between domestic and aggregate import demand is done at the national level, not at the individual agent level”. (Linkage Technical Reference Document, 2005)

Armington

- Pros
  - The Armington specification provides a relatively simple, operational model structure for trade
  - The functional form matches production and cost functions and does not bring “surprises” – kinks, holes, non-existing derivatives and the like.
  - It appears to be a reasonable assumption that households decide to buy either a typical “American car” or a “foreign car”.
- Cons
  - Whether that is as good an argument for any other good, i.e. bread, is a different story.
  - Furthermore, the idea of *national product differentiation* rejects the importance of firm – in contrast to country – specific assets and product characteristics. If the firm is the product defining entity, national boundaries do not present limits. Intra-firm trade, FDI and asset mobility question the usefulness of the Armington setup.
  - *Is an engine made in Mexico in an American car any different from an engine from Detroit?*

Armington

- ... Cons
  - Armington and Monopoly:

    The Armington trade specification grants a degree of monopoly power to any country. The basic idea is that any country's good i is an imperfect substitute with any other country's good i, so that price changes have an effect only to a certain degree on the level of demand.
    - Imports: Armington understates the pressure of increased import competition. With national product differentiation, low-wage, unskilled labor intensive imports cannot replace the domestically produced higher-wage, unskilled labor intensive products. Vice versa, firms in a developing country "cannot" start demanding high-tech, capital intensive machinery – as they are constrained by the Armington elasticity.
    - Exports: Under the Armington assumption, supply restricting policies can raise export prices and therewith the terms of trade, paving the way for welfare improvements. As a good is demanded *in any case* – it enters the utility function symmetrically to other countries' varieties – monopoly power allows for higher export prices and consequently improving relative prices.
  - The monopoly power that is implicit in the Armington setup increases benefits from free trade by default, both through lower import competition and higher export prices.

Sketch of a model...

- Saving:
  - Private sector saving S_P (saving rates s_r and s_w from profit and wage incomes) finances investment *ZI* and new net lending to government *F.*
  - Government saving is S_G (probably negative). Government FoF balance is

    $S_G + F + e\Delta^* = 0$
  - where Δ^* is a loan (or "aid") from the foreign government, fixed in foreign currency terms.
  - Accounts similar for the "starred" foreign country.
- Foreign Flows:
  - Note the Wynne Godley trick of tying the economies together in the bottom rows. For example, home exports flowing out with value *–ZE* become foreign imports P_M^*E with $P_M^*=Z/e$. Similarly for home imports and the transfer.

... Sketch of a model...

- Begin with a one-sector “bastard Keynesian” model based on a CES cost function for wage *w* and “cost of capital” rz.

$$P = [\alpha w^{1-\sigma} + (1-\alpha)(rZ)^{1-\sigma}]^{1/(1-\sigma)}$$

or

$$1 = \alpha\omega^{1-\sigma} + (rz)^{1-\sigma}$$

with $z = Z/p$ and $\omega = w/P$.

- Assume that the nominal wage *w* is pre-determined. Cost minimization provides factor demand functions:

$$L / X = \alpha\omega^{-\sigma}$$

$$K / X = (1-\alpha)(rz)^{-\sigma}$$

... Sketch of a model...

- With “full employment” of *L* and *K* these equations determine profit rate, real wage and *X*.
- On the demand side, the macro balance is

$$C + I + G - X = 0$$

- Set

$$PC = (1 - s_r)rPK + (1 - s_w)wL - PT = [1 - s(\omega)]PX - PT$$

- with T as a lump-sum “real” tax and

$$s(\omega) = s_r - (s_r - s_w)\alpha\omega^{1-\sigma}$$

- Macro balance becomes

$$[I - s(\omega)X] + (G - T) = 0$$

- or private net borrowing + government net borrowing = 0.

… sketch of a model: Closure

- With X and the real wage set from the supply side, 2 of *I, G,* and *T* can be set exogenously.

- Johansen/Meade:
  - With *G* and *I* exogenous, we get the Johansen/Meade "social democratic" closure. Set taxes to ratify full employment.
- Neoclassical Closure:
  - If *G* and *T* are exogenous, we get a "neoclassical" closure with saving-determined investment à la Solow.
- Keynesian Closure:
  - *I, G* and *T* are exogenous: The real wage becomes endogneous along with employment *L.* Then an increase in *I* means that *X* has to rise. Then the capital-output ratio falls or *rz* rises. Then the real wage has to fall from the cost function or goes up in L/X. With the nominal wage fixed, the lower real wage has to come from a higher price *P* – economic expansion is "inflationary". This is the standard bastard Keynesian story about output adjustment.

...sketch of a model: International

- With an open economy, we take into account the Armington aggregate. Its cost is:

$$Z = [\beta P^{1-\theta} + (1-\beta)(\tau e Z^{*})^{1-\theta}]^{1/(1-\theta)}$$

or

$$1 = \beta(1/z)^{1-\theta} + (1-\beta)(\tau\rho)^{1-\theta}$$

where $\rho = eZ^{*}/Z$ is the real exchange rate and $\tau = 1+t$ is the "force" of the tariff.

Note that w and e will determine *P* and *Z* (with *r* coming from the cost function). There will be an Armington expression for *Z** for the foreign country so that *w** and *e* determine *P** and *Z**. Fixing both nominal wages means that we can treat *e* as a variable with an exogenous/endogenous status which follows from closure assumptions.

… sketching the Macro Balance

- The home consumption function is

$$ZC = [1 - s(\omega)]PX - ZT$$

- The macro balance follows as

$$(I - \frac{s(\omega)X}{z}) + (G - T - t\rho E^*) + (E - \rho E^*) = 0$$

- or private net borrowing + government net borrowing + trade surplus = 0.
- The foreign macro balance is

$$(I^* - \frac{s^*(\omega^*)X^*}{z^*}) + (G^* - T^*) + (E^* - \frac{E}{\rho}) = 0$$

- With the foreign loan to the home country $\Delta^* = E^* - (E/\rho)$, the home balance can be restated as:

$$(I - \frac{s(\omega)X}{z}) + (G - T - t\rho E^*) - \rho\Delta^* = 0$$

- Where $\rho\Delta$ is the trade deficit or “foreign savings”.

Marshall-Lerner

- The foreign country (like the US) accepts whatever happens to ***e*** and/or the real exchange rate but it sets the level of the foreign transfer. Assume furthermore the home country chooses *I* and *G. T* is endogenous à la Johansen/Meade.
- The effects of a change in the tariff rate *t* can be analyzed with help of the following expression for the "Aid"/Current account balance:

$$\Delta^* = \frac{1-\beta}{\beta}\left(\frac{P}{\tau e Z^*}\right)^{\theta} X - \frac{Z}{eZ^*}\frac{1-\beta^*}{\beta^*}\left(\frac{eP^*}{Z}\right)^{\theta^*} X^*$$

- Messy expression (prices determine each other). But likely that increases in *t* and ***e*** will reduce *E** and a higher ***e*** will increase *E*.
- For fixed *X* and *X** (constant absorption) an ***approximate*** Marshall-Lerner condition for an increase in ***e*** to reduce the right-hand side is $\theta + \theta^* - 1 > 0$ as in the traditional story.

Some likely model results

- How does the model hang together?
- To start, assume full employment in both countries and a fixed current account. Reduction in home tariff rate: E* and the current account deficit in the home country tend to rise.
- Various things can happen:
  - One is devaluation-induced reshuffling of imports to hold the current account constant.
  - Another is increased lending from the foreign to home country.
  - A third is a reduction in home output and employment in response to the tariff change.

    We discuss each in a bit more detail.

1. An *Elasticity*-Scenario

- If the current account Δ^* is held constant, the nominal exchange rate adjusts in case tariff rates are reduced.
- Results:
  - It can be shown that both *Z* and *Z** – the Armington aggregate price indices – decline and *A* and *A** – the Armington volume indices – increase as imports rise.
  - There presumably will be "welfare improvements" even though real output levels are unchanged.
  - Home value of foreign lending $\rho\Delta^*$ will rise if a nominal devaluation also makes the real exchange rate rise (presumably the case). With "small" changes in tariffs, the lump-sum tax *T* will thereby decline from the government FoF.

- This line of reasoning corresponds to the *elasticities*-approach to the balance of payments adjustment problem.

2. A couple of *Absorption*-Scenarios

- Holding absorption constant and letting foreign lending bear the burden of adjustment provides different results. Suppose ***e*** is constant and Δ^* is the adjusting variable in the Marshall-Lerner condition (slide 24). As above, the experiment starts with tariff reductions.
  - Foreign aid/the home country current account deficit increases.
  - As above, foreign aid increases, and consequently taxes decrease in the Government balance.

- Output and Employment adjustment:
  - Assume that T, G, and I are pre-determined and ***e*** and the level of foreign aid are fixed. Absorption and employment adjust.
  - Output can adjust downward to hold foreign lending constant when tariff rates are reduced.
  - Along lines discussed above in closed economy context, trade liberalization will be associated with job losses, price deflation, and a higher real wage.
  - Finally, what are the employment and output effects of a devaluation in a demand-driven context? How should they be tied to financial developments?

Empirics

- So how could all of this fit into an empirical model?
- World Bank and friends have a huge global trade matrix with 87 countries/regions and 57 commodities, and an incomprehensible “nesting” of production and Armington aggregates in their models. Like gargoyles upon gargoyles in a Gothic cathedral.
- Our SAM presents a 2 country, 3 sector economy.
  - SSA (Sub-Saharan Africa) and ROW (Rest of the world as an approximation for the developed world)
  - Sectors: Agriculture and Manufactures (Traded), Services (Non-traded)
- Some features:
  - The SAM makes use of the GTAP-database v5 (the latest release is v6).
  - GTAP is the database the worldbank model – Linkage – is built around.
  - Except tariff rates, which are updated from recent worldbank publications, the data is solely taken from GTAP v5.

Empirics

- Some problems:
  - The disaggregation in bilateral trade flows between SSA and ROW shows that ROW has a considerable current account surplus with itself, cell {22, 16} – which clearly should not be the case.
  - GTAP does not provide data for the government deficit, which in the standard World Bank model is assumed to be 0, as taxes are the adjusting variable.
  - In the FoF, only the total of investment and the “Aid”-inflow are items presented by GTAP.

- However, our SAM shows stylized developing–developed country relationships and allows analysis of the aforementioned closure issues.

Open questions

- Now putting together a model to solve numerically.
- Issues: “Gains from trade” in an elasticities framework are always around 1% of GDP in numerical models. We expect the same.
- How will these map into aid flows or employment losses?
- Why doesn’t World Bank do these alternatives (and others), along with remembering 50-year old open economy macroeconomics?

2 Sept. 05

One-Sector Armington Story

Here's a one-sector version of the Armington set-up (I think), with a focus on closure issues. The basic story should carry over to multisectoral versions.

In the first two rows of the SAM are "domestic" (subscript *D*) and "imported" (subscript *M)* components of an Armington aggregate *A* with price *Z* which shows up in the third row. I assume that there is an imported component of exports, to avoid dragging in some kind of CET story. The home country price of imports (or foreign exports E^*) is $P_M = (1+t)eZ^* = \tau eZ^*$ where Z^* is the price of the foreign Armington aggregate and τ is the "force" of the home country tariff *t*. To keep down notation I assume zero tariffs in the foreign country. As usual in Godley-style 2-country SAMs, the "cross-border" transactions in home and foreign exports (*E* and E^*) and a loan from the foreign to the home government (Δ^*) tie the economies together in the bottom 3 rows. A transaction gets an exchange rate conversion and a sign flip when it crosses borders.

The price of home capital goods is *Z,* same as investment. The private sector saves S_P (with wage and profit income components as discussed below) which presumably exceeds the value of investment *ZI*. It therefore lends *F* to the government. The home government has 3 sources of funds: saving S_G, new loans from the private sector or *F*, and a new loan $e\Delta^*$ from the foreign government. Presumably $S_G < 0$.

The foreign story is similar. Its imports are home exports *E* with a foreign price Z/e. The foreign loan Δ^* is set in terms of foreign prices, and so on.

So look first at a closed economy at home, but with a price *Z* for capital goods which may differ from the overall price level *P.* The CES cost function for *P* is

$$P = [\alpha w^{1-\sigma} + (1-\alpha)(rZ)^{1-\sigma}]^{1/(1-\sigma)} \qquad (1)$$

or

$$1 = \alpha\omega^{1-\sigma} + (rz)^{1-\sigma} \qquad (2)$$

with $\omega = w/P$ and $z = Z/P$. To anchor the price system, assume that the nominal wage *w* is pre-determined or we measure output in terms of "wage units" like Keynes.

So with cost minimization

$$L/X = \alpha\omega^{-\sigma} \quad \text{or} \quad wL/PX = \omega L/X = \alpha\omega^{1-\sigma} \tag{3}$$

and

$$K/X = (1-\alpha)(rz)^{-\sigma} \quad \text{or} \quad rZK/PX = rzK/X = (1-\alpha)(rz)^{1-\sigma} \quad . \tag{4}$$

Via standard duality results, equations (2)-(4) imply a neoclassical (CES) production function tying X to *L* and *K.* It also follows from (2) that

$$\omega L + rzK = [\alpha\omega^{1-\sigma} + (1-\alpha)(rz)^{1-\sigma}]X = X \quad . \tag{5}$$

Suppose that *L* and *K* are fixed by a full employment assumption. Then substituting from (5) for X into (3) and (4) and some simplification give two expressions

$$1 = \alpha\omega^{-\sigma}(\omega + rk)$$

and

$$1 = (1-\alpha)(rz)^{-\sigma}[(\omega/k) + r]$$

with $k = K/L$. These equations can be solved for ω and *rz* which then give *X*. From (3) we have $P = w[(L/X)/\alpha]^{1/\sigma}$ so the home price level is proportional to the money wage.

Now look at the demand side, or

$$C + I + G - X = 0 \quad . \tag{6}$$

If there is a lump-sum tax *T* on real income then a plausible consumption function is

$$PC = (1-s_r)rPK + (1-s_w)wL - PT = [1-s(\omega)]PX - PT \tag{7}$$

with $s(\omega) = s_r - (s_r - s_w)\alpha\omega^{1-\sigma}$. From (3) if $\sigma < 1$ then a higher real wage ω increases the labor share and reduces the private saving rate. Plugging back into (6) gives

$$[I - s(\omega)X] + (G - T) = 0 \tag{8}$$

as the macro balance condition. If X and ω come from the supply side then two of the three variables *I, G,* and *T* can be set exogenously. If *T* is endogenous then we get the Johansen/Meade "social democratic" closure of adjusting fiscal policy to get full employment. Or

one could set both *G* and *T* and get a "neoclassical" closure with saving-determined investment à la Solow.

If *T* , *G,* and *I* are all pre-determined then the usual step is to endogenize ω in (8) along with employment *L.* Then an increase in *I* means that *X* has to rise. Then K / X falls or *rz* rises in (4). Then ω has to fall in the cost function (2) or L / X goes up in (3). With the nominal wage fixed, the lower ω has to come from a higher price *P* or economic expansion is "inflationary."

Now bring in the Armington aggregate *A* (of domestic output *X* and imports E^*) with price *Z*. The cost function is

$$Z = [\beta P^{1-\theta} + (1-\beta)(\tau e Z^*)^{1-\theta}]^{1/(1-\theta)} \quad . \tag{9}$$

Note that *w* and *e* will determine *P* and *Z* from (1) and (9). There will be an expression similar to (9) for the foreign country so that w^* and *e* determine P^* and Z^*. Fixing both nominal wages means that we can treat *e* as a variable with an exogenous/endogenous status which follows from closure assumptions.

The intensive form of (9) is

$$1 = \beta(1/z)^{1-\theta} + (1-\beta)(\tau\rho)^{1-\theta} \tag{10}$$

with $\rho = eZ^* / Z$ as the real exchange rate. It follows that

$$PX + \tau e Z^* E^* = ZA \quad . \tag{11}$$

Input ratios are

$$X / A = \beta(P / Z)^{-\theta} \tag{12}$$

and

$$E^* / A = (1-\beta)(\tau e Z^* / Z) \tag{13}$$

which imply that

$$E^* = \frac{1-\beta}{\beta}\left(\frac{\tau e Z^*}{P}\right)^{-\theta} X \quad . \tag{14}$$

The analogous expression for home exports (or foreign imports) is

$$E = \frac{1-\beta^*}{\beta^*}\left(\frac{Z / e}{P^*}\right)^{-\theta^*} X^* \quad . \tag{15}$$

Assume that the home consumption function is

$$ZC = [1 - s(\omega)]PX - ZT \quad .$$

Using this expression and (11) one can show that the macro balance condition is

$$(I - \frac{s(\omega)X}{z}) + (G - T - t\rho E^*) + (E - \rho E^*) = 0 \quad . \tag{16}$$

The foreign macro balance is

$$(I^* - \frac{s^*(\omega^*)X^*}{z^*}) + (G^* - T^*) + (E^* - \frac{E}{\rho}) = 0 \quad . \tag{17}$$

Let the foreign loan to the home country be

$$\Delta^* = E^* - (E / \rho) \quad . \tag{18}$$

Then (16) can be restated as

$$(I - \frac{s(\omega)X}{z}) + (G - T - t\rho E^*) - \rho\Delta^* = 0 \tag{19}$$

so that $\rho\Delta^*$ is the home trade deficit or "foreign savings."

Suppose that the foreign country (like the US) accepts whatever happens to *e* and/or ρ. On the other hand it sets the level of the foreign transfer Δ^*. For the moment assume that the home country chooses *I* and *G* in (19) so *T* is endogenous à la Johansen/Meade. Now we have to worry about the implications of a change in the tariff rate *t.* From (13) and (14) Δ^* can be restated as

$$\Delta^* = \frac{1-\beta}{\beta}(\frac{P}{\tau eZ^*})^{\theta} X - \frac{Z}{eZ^*}\frac{1-\beta^*}{\beta^*}(\frac{eP^*}{Z})^{\theta^*} X^* \quad . \tag{20}$$

Because the price variables all determine one another this is a pretty messy expression (as illustrated below). However it is likely that increases in *t* and *e* will reduce E^* and a higher *e* will increase *E*. For fixed *X* and X^* an *approximate* Marshall-Lerner condition for an increase in *e* to reduce the right-hand side is $\theta + \theta^* - 1 > 0$ as in the traditional story.

So assume full employment in both countries and a fixed Δ^*. Then a reduction in the home tariff rate *t* will make E^* and Δ^* tend to rise. Various scenarios can ensue. One is

devaluation-induced reshuffling of imports and (constant) domestic output levels. Another is increased lending from the foreign to home country. A third is adjustment of employment to the tariff change.

Devaluation The first way to hold Δ^* constant is via a nominal devaluation. With full employment and fixed nominal wages in both countries all prices in both countries except *e, Z,* and Z^* will stay constant. Let $\phi = \tau eZ^*E^* / ZA$ and $\phi^* = (Z/e)E/Z^*A^*$ in the base solution. Then by standard hat calculus tricks we have

$$\hat{Z} = (1-\phi)\hat{P} + \phi(\hat{\tau} + \hat{e} + \hat{Z}^*)$$

and

$$\hat{Z}^* = (1-\phi^*)\hat{P}^* + \phi^*(\hat{Z} - \hat{e})$$

in which $\hat{Z} = dZ/Z$, etc.

With full employment and fixed nominal wages in both countries, $\hat{P} = \hat{P}^* = 0$. We can solve for the log-changes of the Armington prices as

$$\hat{Z} = [\phi/(1-\phi\phi^*)][\hat{\tau} + (1-\phi^*)\hat{e}] \qquad (21)$$

and

$$\hat{Z}^* = [\phi^*/(1-\phi\phi^*)][\phi\hat{\tau} - (1-\phi)e^*] \quad . \qquad (22)$$

For $\hat{\tau} < 0$, the exchange rate *e* will have to rise less than proportionately to hold Δ^* constant in (20) because it affects both imports and exports. The implication is that $\hat{Z} < 0$ in (21). Evidently $\hat{Z}^* < 0$ in (22).

Falling prices of the Armington aggregates in both countries will be accompanied by more imports and increases in *A* and A^*. There presumably will be welfare improvements even though real output levels are unchanged. On the macro side, the home value of foreign lending $\rho\Delta^*$ will rise if a nominal devaluation also makes the real exchange rate rise (presumably the case). With "small" changes in tariffs, the lump-sum tax *T* will thereby decline.

Foreign Lending To let foreign lending bear the burden of adjustment, assume *e* is constant and let Δ^* be the endogenous variable in (20). A lower tariff *t* will increase the right-hand side. The resulting increase in Δ^* will again by accompanied by lower home country taxes *T.*

Unemployment Finally, assume that *T, G,* and *I* are pre-determined and *e* and Δ^* are fixed. If employment is endogenous, then *X* can adjust downward to hold Δ^* constant in (20) when *t* is reduced (along the lines discussed above). Liberalization is associated with job losses, price deflation, and a higher real wage.

Effects of the exchange rate In the latter two cases one can also check the effects of exogenous exchange rate changes on either the foreign loan or employment. Devaluation could be either expansionary or contractionary (I guess) with the latter more likely if intermediate imports are brought into the story.

Output and Import flows By source																		
		PC_D	PG_D	PI_D	PE_D				PX		$P^*C_D^*$	$P^*G_D^*$	$P^*I_D^*$	$P^*E_D^*$				P^*X^*
		$P_M C_M$	$P_M G_M$	$P_M I_M$	$P_M E_M$	$-P_M E^*$			0		$P_M^* C_M^*$	$P_M^* G_M^*$	$P_M^* I_M^*$	$P_M^* E_M^*$	$-P_M^* E$			0
Aggregate																		
		ZC	ZG	ZI	ZE				ZA		Z^*C^*	Z^*G^*	Z^*I^*	Z^*E^*				Z^*A^*
Factor payments																		
	wL								Y_w	w^*L^*								Y_w^*
	rZK								Y_r	$r^*Z^*K^*$								Y_r^*
Incomes																		
	V								V	V^*								V^*
		T				teZ^*E^*			Y_G		T^*							Y_G^*
Flows of Funds																		
		S_P		$-ZI$			$-F$		0		S_P^*		$-Z^*I^*$			$-F^*$		0
			S_G				F	$e\Delta^*$	0			S_G^*				F^*	$-\Delta^*$	0
Cross-border																		
					$-ZE$										$(Z/e)E$			
						eZ^*E^*								$-Z^*E^*$				
								$-e\Delta^*$									Δ^*	0
Totals																		
	PX	V	Y_G	0	0	0	0	0		P^*X^*	V^*	Y_G^*	0	0	0	0	0	

Two country SAM: Sub-Saharan Africa and "Rest of the World"

1997 Billion U.S. Dollars. Source: GTAP Database 5.0, except Tariff data

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
SSA	Cost:A	Cost:I	Cost:H	Priv	Gov	Exp(fob)	ExpSubs	CapForm	M	Treas	Aid	SUM			
M:A				6.64					-6.64						
Armington:A	35.82	2.86	4.44	78.84		14.31			-6.64			129.63			
M:I				22.06				18.05	-40.10						Bilateral Trac
Armington:I	9.19	44.48	37.09	54.97		65.17	0.01	59.24	-40.10			230.04			Intra-
Armington:H	19.81	41.69	74.58	97.58	53.82							287.48			regional
Wage-Income	35.36	49.34	93.77									178.48			SSA
Profit-Income	25.19	72.86	63.02									161.08	Tariff Revenue		
Gov-Income	-2.77	-3.43	-3.18	41.34			-0.01					42.19	10.25		
FoF:Priv				66.81				-59.24		-7.58	0.00	0.00			
FoF:Gov					-11.63					7.58	4.05	0.00	Incl Tariff	Incl Tariff	World Prices
Imp(H,Agr)	2.41	0.26	0.45						6.64			9.76	0.71	9.05	0.61
Imp(H,Ind)	4.62	21.99	17.31						40.10			84.02	8.24	75.78	7.49
Exp(H,Agr)						-14.31						-14.31			*-0.61*
Exp(H,Ind)						-65.17						-65.17			*-7.49*
Aid											-4.05	-4.05			0.00
SUM	129.63	230.04	287.48	339.55	42.19	0.00	0.00	0.00	0.00	0.00	0.00				

SSA-Summary Stats

Column-Row Discrepancy and %

A	I	H	Priv	Gov
0.00	0.00	0.00	0.00	0.00
1.00	1.00	1.00	1.00	1.00

Agriculture

Industrial

Macro-Balance SSA:

Private			Government			International		
Investment	Lending	Saving	G-expenditu	Borrowing	G-Income	Export	Imports	
59.24	7.58	66.81	53.82	-7.58	42.19	79.47	83.53	0.00

Ratio to Value Added: VA = 339.55

S		I	G		Y-G	E	M	CA/GDP	Def/GDP
0.17		0.20	0.16		0.12	0.23	0.25	-0.01	0.03

16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32
					SUM	Cost:A	Cost:I	Cost:H	Priv	Gov	Exp(fob)	ExpSubs	CapForm	M	Treas	Aid
									0.00					0.00		
					4,728.21	1,419.53	126.29	390.16	2,585.27		538.62			-331.65		
de Matrix									1,565.21				1,180.77	-2,745.97		
Extra-	Extra-	Intra-			21,507.67	392.41	5,144.26	2,818.42	3,784.52		5,645.27	7.53	6,461.23	-2,745.97		
regional	regional	regional			27,271.72	678.05	2,939.24	7,951.01	11,411.48	4,291.94						
SSA	ROW	ROW			16,605.06	960.73	6,458.06	9,186.27								
				Tariff Revenue	12,885.03	1,081.96	4,842.30	6,960.77								
				366.31	3,537.83	-117.50	-337.88	-855.00	4,489.42			-7.53				
					0.00				7,219.39				-6,461.23		-758.16	0.00
World Prices	World Prices	World Prices	Incl Tariff	Incl Tariff	0.00					-754.11					758.16	-4.05
7.77	-7.77	*-530.84*			-538.62						-538.62					
67.66	*-67.66*	*-5,577.61*			-5,645.27						-5,645.27					
-13.70	13.70	530.84	15.62	615.78	631.40	206.88	36.69	56.19						331.65		
-57.67	57.67	5,577.61	58.25	5,856.49	5,914.74	106.13	2,298.73	763.91						2,745.97		
4.05	-4.05	0.00			4.05											4.05
						4,728.20	21,507.67	27,271.72	29,490.09	3,537.83	0.00	0.00	0.00	0.00	0.00	0.00

Tariff Matrix	Im-Row	Im-SSA
Ex-Row	1.160	1.165
Ex-SSA	1.140	1.165
Ex-Row	1.050	1.120
Ex-SSA	1.010	1.100

QUAD-Summary Stats

Column-Row Discrepancy and %

A	I	H	Priv	Gov
-0.01	0.01	0.00	0.00	0.00
1.00	1.00	1.00	1.00	1.00

Macro-Balance ROW:

Private			Government			International		
Investment	Lending	Saving	G-expenditu	Borrowing	G-Income	Export	Imports	
6,461.23	758.16	7,219.39	4,291.94	-758.16	3,537.83	6,183.88	6,179.83	0.00

Ratio to Value Added: VA = 29,490.09

S		I	G		Y-G	E	M	CA/GDP	Def/GDP
0.22		0.24	0.15		0.12	0.21	0.21	0.00	0.03