Defining Terms of Trade

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- Which of these approaches is more appropriate?

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  - Reciprocity guides nations from Nash policies to efficient policies
  - Market access rules prevent manipulation in non-tariff policies

Notation

$C_{HH}, C_{HF}, C_{FH}, C_{FF}$	Consumption indices (destination, origin)
Z_H, Z_F	Consumption of outside good
$U_H(C_{HH}, C_{HF}, Z_H)$	Home utility
$U_F(C_{FH}, C_{FF}, Z_F)$	Foreign utility
$\overline{L_H}, \overline{L_F}$	Labor endowments
$L_{CH}(C_{HH}, C_{FH})$	Home labor requirement for C
$L_{CF}(C_{FF}, C_{HF})$	Foreign labor requirement for C
L_{ZH}, L_{ZF}	Labor requirements for Z
P_{WH}, P_{WF}	Terms of trade for C sector exports
$P_{HH}, P_{HF}, P_{FH}, P_{FF}$	Local price indices for C sector
τ	Iceberg transport cost

- Next steps
  - Find global planning FOCs
  - Find national planning FOCs with no terms-of-trade manipulation
  - Show solutions are equivalent

Global Planner's Problem

- Optimization

$$\max_{\substack{C_{HH}, C_{HF}, Z_H, \\ C_{FH}, C_{FF}, Z_F}} U_H + \lambda_U U_F$$

$$s.t.\ Z_H + Z_F = L_{ZH} + L_{ZF} \text{ and}$$

$$L_{CH}\left(C_{HH}, C_{FH}\right) + L_{CF}\left(C_{FF}, C_{HF}\right) + L_{ZH} + L_{ZF} = \overline{L_H} + \overline{L_F}$$

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- Lagrangian

$$U_H\left(C_{HH}, C_{HF}, Z_H\right) + \lambda_U U_F\left(C_{FH}, C_{FF}, Z_F\right) -$$
$$\lambda_W(L_{CH}\left(C_{HH}, C_{FH}\right) + L_{CF}\left(C_{FF}, C_{HF}\right) + Z_H + Z_F - \overline{L_H} - \overline{L_F}).$$

Global First-Order Conditions

$$\frac{dU_H}{dC_{HH}} = \lambda_W \frac{dL_{CH}}{dC_{HH}},$$

$$\frac{dU_H}{dC_{HF}} = \lambda_W \frac{dL_{CF}}{dC_{HF}},$$

$$\frac{dU_H}{dZ_H} = \lambda_W,$$

$$\lambda_U \frac{dU_F}{dC_{FF}} = \lambda_W \frac{dL_{CF}}{dC_{FF}},$$

$$\lambda_U \frac{dU_F}{dC_{FH}} = \lambda_W \frac{dL_{CF}}{dC_{FH}},$$

$$\lambda_U \frac{dU_F}{dZ_F} = \lambda_W,$$

$$L_{CH}\left(C_{HH}, C_{FH}\right) + L_{CF}\left(C_{FF}, C_{HF}\right) + Z_H + Z_F = \overline{L_H} + \overline{L_F}.$$

National Planning Problems

$$\max_{C_{HH}, C_{HF}, Z_H, C_{FH}} U_H \tag{H}$$

$$s.t.\ L_{CH}\left(C_{HH}, C_{FH}\right) + L_{ZH} = \overline{L_H}, \text{ and}$$

$$\tau P_{WH} C_{FH} + L_{ZH} - Z_H = \tau P_{WF} C_{HF}$$

$$\max_{C_{FH}, C_{FF}, Z_F, C_{HF}} U_F \tag{F}$$

$$s.t.\ L_{CF}\left(C_{FF}, C_{HF}\right) + L_{ZF} = \overline{L_F}. \text{ and}$$

$$\tau P_{WF} C_{HF} + L_{ZF} - Z_F = \tau P_{WH} C_{FH}$$

Lagrangians for National Planning Problems

$$\begin{aligned}\mathcal{L}_H &= U_H\left(C_{HH}, C_{HF}, Z_H\right) - \\ &\quad \lambda_H(L_{CH}\left(C_{HH}, C_{FH}\right) + Z_H + \tau P_{WF} C_{HF} - \tau P_{WH} C_{FH} - \overline{L_H}).\end{aligned}$$

$$\begin{aligned}\mathcal{L}_F &= U_F\left(C_{FH}, C_{FF}, Z_F\right) - \\ &\quad \lambda_F(L_{CF}\left(C_{FF}, C_{HF}\right) + Z_F + \tau P_{WH} C_{FH} - \tau P_{WF} C_{HF} - \overline{L_F}).\end{aligned}$$

National Planning First-Order Conditions

$$\frac{dU_H}{dC_{HH}} = \lambda_H \frac{dL_{CH}}{dC_{HH}}, \qquad \frac{dU_F}{dC_{FF}} = \lambda_F \frac{dL_{CF}}{dC_{FF}},$$

$$\frac{dU_H}{dC_{HF}} = \lambda_H \tau P_{WF}, \qquad \tau P_{WF} = \frac{dL_{CF}}{dC_{HF}},$$

$$\tau P_{WH} = \frac{dL_{CH}}{dC_{FH}}, \qquad \frac{dU_F}{dC_{FH}} = \lambda_F \tau P_{WH},$$

$$\frac{dU_H}{dZ_H} = \lambda_H, \qquad \frac{dU_F}{dZ_F} = \lambda_F,$$

$$L_{CH}\left(C_{HH}, C_{FH}\right) + Z_H + \tau P_{WF} C_{HF} - \tau P_{WH} C_{FH} = \overline{L_H},$$

$$L_{CF}\left(C_{FF}, C_{HF}\right) + Z_F + \tau P_{WH} C_{FH} - \tau P_{WF} C_{HF} = \overline{L_F}.$$

Decentralization Result

Proposition

The national planning problems (H) and (F) (where nations act as if they cannot influence P_{WH} and P_{FH}) jointly yield the same allocation as the global planning problem with $\lambda_U = \lambda_H^* / \lambda_F^*$.

Next Step

- Can we further characterize these results in terms of local prices faced by consumers and producers?
- Previous literature (e.g. Bagwell and Staiger, 1999) finds when government policy implies zero first-order effects of local price changes on government's objectives, then policies are Pareto efficient
  - This result is then useful in characterizing principles that can guide governments from noncooperative to cooperative policy
- Is there an analogous result in my general setting?

Decentralization with Consumers and Firms

- Suppose local traded prices $P_{HH}, P_{HF}, P_{FH}, P_{HH}$
- Consumers have Marshallian Demand functions

$$C_{HH}, C_{HF}, Z_H \text{ depend on } \{P_{HH}, P_{HF}, I_H\}$$
$$C_{FF}, C_{FH}, Z_F \text{ depend on } \{P_{FF}, P_{FH}, I_F\}$$

- National income

$$\begin{aligned} I_H &= \overline{L_H} + P_{HH}(C_{HH} + \tau C_{FH}) - L_{CH}(C_{HH}, C_{FH}) + \\ &\quad (P_{HF} - \tau P_{WF})C_{HF} + \tau(P_{WH} - P_{HH})C_{FH}. \\ I_F &= \overline{L_F} + P_{FF}(C_{FF} + \tau C_{HF}) - L_{CF}(C_{FF}, C_{HF}) + \\ &\quad (P_{FH} - \tau P_{WH})C_{FH} + \tau(P_{WF} - P_{FF})C_{HF}. \end{aligned}$$

- Implicitly define $I_H(P_{HH}, P_{HF}, P_{FF}, P_{FH}, P_{WH}, P_{WF})$ and $I_F(\cdot)$

Efficiency Properties

- Home indirect utility functions

$$\begin{aligned}
& V_H(P_{HH}, P_{HF}, P_{FF}, P_{FH}, P_{WH}, P_{WF}) \\
= \;& \mathcal{L}_H(C_{HH}(\cdot), C_{HF}(\cdot), C_{FH}(\cdot), Z_H(\cdot), P_{WH}, P_{WF})
\end{aligned}$$

- Using envelope arguments, we find

$$\frac{dV_H}{dP_{HH}} = \frac{dV_H}{dP_{HF}} = \frac{dV_H}{dP_{FH}} = \frac{dV_H}{dP_{FF}} = 0,$$

$$\frac{dV_H}{dP_{WH}} = \lambda_H^* \tau C_{FH}, \frac{dV_H}{dP_{WF}} = -\lambda_H^* \tau C_{HF}$$

- So efficient policies also satisfy conditions for "political optimum"

Specific Application: Krugman (1980), CFF (2014)

Consumption indices	$C_{HH} = c_{HH} N_H^{\frac{\epsilon}{\epsilon-1}},\ C_{FH} = c_{FH} N_H^{\frac{\epsilon}{\epsilon-1}},$ $C_{HF} = c_{HF} N_F^{\frac{\epsilon}{\epsilon-1}},\ C_{FF} = c_{FF} N_F^{\frac{\epsilon}{\epsilon-1}}$
Local price indices	$P_{HH} = p_{HH} N_H^{\frac{-1}{\epsilon-1}},\ P_{FH} = p_{FH} N_H^{\frac{-1}{\epsilon-1}}$ $P_{HF} = p_{HF} N_F^{\frac{-1}{\epsilon-1}},\ P_{FF} = p_{FF} N_F^{\frac{-1}{\epsilon-1}}$
Terms of trade	$P_{WH} = p_{WH} N_H^{\frac{-1}{\epsilon-1}}, P_{WF} = p_{WF} N_F^{\frac{-1}{\epsilon-1}}$
Utility functions	$U_H = Z_H^{1-\alpha} C_H^{\alpha}, U_F = Z_F^{1-\alpha} C_F^{\alpha},$ $C_H = (C_{HH}^{\frac{\epsilon-1}{\epsilon}} + C_{HF}^{\frac{\epsilon-1}{\epsilon}})^{\frac{\epsilon}{\epsilon-1}},$ $C_F = (C_{FF}^{\frac{\epsilon-1}{\epsilon}} + C_{FH}^{\frac{\epsilon-1}{\epsilon}})^{\frac{\epsilon}{\epsilon-1}}$
Home labor in C	$L_{CH} = \left(\frac{\epsilon}{\epsilon-1}\right)\left(C_{HH} + \tau C_{FH}\right)^{\frac{\epsilon-1}{\epsilon}}\left((\epsilon-1) f_H\right)^{\frac{1}{\epsilon}}$
Foreign labor in C	$L_{CF} = \left(\frac{\epsilon}{\epsilon-1}\right)\left(C_{FF} + \tau C_{HF}\right)^{\frac{\epsilon-1}{\epsilon}}\left((\epsilon-1) f_F\right)^{\frac{1}{\epsilon}}$

Derivation of Labor Requirements

- Existence of $L_{CH}(C_{HH}, C_{FH})$ is nontrivial
- First find $N_H(C_{HH}, C_{FH})$ from free entry

$$\begin{aligned} c_{HH} + \tau c_{FH} &= (\epsilon - 1) f_H, \\ C_{HH} + \tau C_{FH} &= N_H^{\frac{\epsilon}{\epsilon - 1}} (\epsilon - 1) f_H, \text{ and} \\ N_H &= (C_{HH} + \tau C_{FH})^{\frac{\epsilon - 1}{\epsilon}} ((\epsilon - 1) f_H)^{\frac{1-\epsilon}{\epsilon}}. \end{aligned}$$

- Then

$$\begin{aligned} L_{CH} &= (f_H + c_{HH} + \tau c_{FH}) N_H \\ &= f_H N_H + (C_{HH} + \tau C_{FH}) N_H^{\frac{-1}{\epsilon - 1}} \\ &= \left(\frac{\epsilon}{\epsilon - 1}\right) (C_{HH} + \tau C_{FH})^{\frac{\epsilon - 1}{\epsilon}} ((\epsilon - 1) f_H)^{\frac{1}{\epsilon}}. \end{aligned}$$

Solution to Global Planning Problem

- As already shown in CFF, first-best policies yield prices

$$\begin{aligned} p_{HH} &= p_{FF} = 1 \\ p_{HF} &= p_{FH} = \tau \end{aligned}$$

- In the available policy environment, these are implemented with
  - domestic subsidies eliminating monopoly distortions
  - net zero trade taxes (not necessarily free trade)

Solution to Home and Foreign Planner's Problems

- Marginal Labor Requirements

$$\frac{dL_{CH}}{dC_{HH}} = N_H^{\frac{-1}{\epsilon-1}} \text{ and } \frac{dL_{CH}}{dC_{FH}} = \tau N_H^{\frac{-1}{\epsilon-1}},$$
$$\frac{dL_{CF}}{dC_{FF}} = N_F^{\frac{-1}{\epsilon-1}} \text{ and } \frac{dL_{CF}}{dC_{HF}} = \tau N_F^{\frac{-1}{\epsilon-1}}.$$

- At equilibrium when nations do not manipulate terms of trade

$$\tau P_{WH} = \frac{dL_{CH}}{dC_{FH}} \text{ and } \tau P_{WF} = \frac{dL_{CF}}{dC_{HF}}$$

- These equations hold when $p_{WH} = p_{WF} = 1$
- Implementing this "political optimum" requires
  - free trade
  - domestic subsidies eliminating monopoly distortion

What About Individual Product Prices?

- An alternative definition of terms of trade is nations act is if they cannot influence p_{WH} and p_{WF}
  - But nations can influence extensive margins affecting P_{WH} and P_{WF}
- Prior results
  - Bagwell and Staiger (2015) show nations still choose efficient trade policies, but these are not free trade
  - CFF (2014) show if nations have a domestic subsidy, the first-best free trade policies are not the solution to this problem
- I show when governments choose the number of firms, Home does not internalize the benefits of new Foreign varieties
  - CFF (2014) label this as a fiscal burden shifting externality

Summary of General Results for Product Prices

- We can define Home & Foreign planning problems where nations act as if they cannot influence p_{WH} and p_{WF}
- Solutions to these planning problems satisfy

$$
\begin{aligned}
\frac{dV_H}{dp_{HH}} &= \frac{dV_H}{dp_{HF}} = \frac{dV_H}{dp_{FH}} = 0, \\
\frac{dV_F}{dp_{FF}} &= \frac{dV_F}{dp_{HF}} = \frac{dV_F}{dp_{FH}} = 0.
\end{aligned}
$$

- But if domestic consumption influences extensive margin

$$\frac{dN_H}{dC_{HH}} \neq 0 \text{ and } \frac{dN_F}{dC_{FF}} \neq 0$$

  - then we have

$$\frac{dV_H}{dp_{FF}} \neq 0, \frac{dV_F}{dp_{HH}} \neq 0.$$

  - Policies such as domestic subsidies lead to international inefficiency.

Reciprocity

- Another core result is that reciprocity can guide nations from noncooperative policies
- Some notation:
  - Policies Λ_H and Λ_F, World prices $P_W = \{P_{WH}, P_{WF}\}$,
  - Planner choices: $X_H = \{C_{HH}, C_{HF}, C_{FH}, Z_H\}$, $X_F = \{C_{FF}, C_{HF}, C_{FH}, Z_H\}$
- Nash equilibrium conditions

$$\begin{aligned}\left(\frac{d\mathcal{L}_H}{dX_H} + [C_{FH} \;\; C_{HF}]\frac{dP_W}{dX_H}\right)\frac{dX_H}{d\Lambda_H} &= 0, \text{ and} \\ \left(\frac{d\mathcal{L}_F}{dX_F} + [C_{FH} \;\; C_{HF}]\frac{dP_W}{dX_F}\right)\frac{dX_F}{d\Lambda_F} &= 0.\end{aligned}$$

- Define policy changes $d\Lambda_H$ and $d\Lambda_F$ to be reciprocal if they serve to undo terms-of-trade manipulation

$$[C_{FH} \;\; C_{HF}]\left(\frac{dP_W}{dX_H}\frac{dX_H}{d\Lambda_H} + \frac{dP_W}{d\Lambda_F}\right) = 0,$$

Benefits of Policy Changes satisfying Reciprocity

- Home welfare effects of policy changes

$$\left(\frac{d\mathcal{L}_H}{dX_H} + [C_{FH}\ \ C_{HF}]\frac{dP_W}{dX_H}\right)\frac{dX_H}{d\Lambda_H} +$$
$$\left(\frac{d\mathcal{L}_H}{dX_H} + [C_{FH}\ \ C_{HF}]\frac{dP_W}{dX_H}\right)\frac{dX_H}{d\Lambda_F} + [C_{FH}\ \ C_{HF}]\frac{dP_W}{d\Lambda_F}.$$

- At Nash equilibrium this reduces to

$$[C_{FH}\ \ C_{HF}]\frac{dP_W}{d\Lambda_F},$$

- which by definition of reciprocal policy changes equals

$$-[C_{FH}\ \ C_{HF}]\frac{dP_W}{dX_H}\frac{dX_H}{d\Lambda_H} > 0.$$

Conclusion

- In a wide range of models, efficient policies result if nations do not manipulate their terms of trade
- When policy influences extensive margins, the appropriate terms-of-trade definition is the price of the traded bundle
- The principle of reciprocity can apply across many policies
- Further directions
  - Evidence of extensive-margin terms-of-trade effects on noncooperative tariffs or cooperative tariff reductions?
  - Can we characterize policy space limitations that lead to international externalities other than terms of trade?