Aid and the Supply Side: Public Investment, Export Performance and Dutch Disease in Low Income Countries

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Supplementary Materials

Model equations

Appendix I: Model equations

This appendix sketches the equations of the basic simulation model used in this paper. GAMS programmes corresponding to the variants of the model can be obtained at:

http://www.economics.ox.ac.uk/Members/christopher.adam/Adam_Bevan_GAMS_programmes.htm

The model

Sectors (*i*)
Private (*ip)*
Food
Cash Crops
Manufacturing
Services

Public
Public Services (*pub*)

Rural (*ir*) {Food, Cash Crops}
Urban (*iu*) {Manufacturing, Services, Public}

Labour categories (*lc*)
Unskilled labour (*u)*
Skilled labour (*s*)

Households (*hh*)
Rural (*rur)*
Urban unskilled (*urbu*)
Urban skilled (*urbs*)

Prices

Import prices $$pm_i = E.pm_i^w(1+\tau_i^m) \quad (1)$$

Export prices $$pe_i = E.pe_i^w(1-\tau_i^e) \quad (2)$$

Composite consumption prices $$pc_i = \frac{pd_i.xd_i + pm_i.m_i}{q_i} \quad (3)$$

Composite output prices $$px_i = \frac{pd_i.xd_i + pe_i.e_i}{x_i} \quad (4)$$

Value added prices $$pva_i = px_i - \sum_j a_{i,j}.pc_j \quad (5)$$

Capital goods prices $$pk_i = \sum_j b_{i,j}.pc_j \quad (6)$$

Composite labour price $$pl_i = \frac{\Phi_{i,s}.w_s.L_{i,s} + \Phi_{i,u}.w_u.L_{i,u}}{LC_i} \quad (7)$$

Output and Factor Demands

Production Function $$x_i = A_i H_i^{\alpha h_i} LC_i^{\alpha l_i} K_i^{\alpha k_i} KG^{\alpha kg_i} \quad (8)$$

Labour market FOC $$LC_i = \frac{\alpha l_i.pva_i.x_i}{pl_i} \quad (9)$$

Labour aggregation $$LC_i = B_i \left[\omega_i L_{i,u}^{\left(\frac{\sigma l-1}{\sigma l}\right)} + (1-\omega_i) L_{i,s}^{\left(\frac{\sigma l-1}{\sigma l}\right)} \right]^{\left(\frac{\sigma l}{\sigma l-1}\right)} \quad (10)$$

Skill composition $$\left(\frac{L_u}{L_s}\right)_i = \left[\left(\frac{\omega}{1-\omega}\right)_i \left(\frac{\Phi_{i,s} w_s}{\Phi_{i,u} w_u}\right) \right]^{\sigma l} \quad (11)$$

Labour market equilibrium $$\sum_i L_{i,lc} + L_{pub,lc} = \bar{L}_{lc} \quad (12)$$

Composite output $$x_i = C_i \left[\beta_i e_i^{\left(\frac{1+\sigma t}{\sigma t}\right)} + (1-\beta_i) xd_i^{\left(\frac{1+\sigma t}{\sigma t}\right)} \right]^{\left(\frac{\sigma t}{1+\sigma t}\right)} \quad (13)$$

Relative supplies $$\left(\frac{e}{xd}\right)_i = \left[\left(\frac{1-\beta}{\beta}\right)_i \left(\frac{pe}{pd}\right)_i \right]^{\sigma t} \quad (14)$$

Composite consumption $$q_i = D_i \left[\delta_i m_i^{\left(\frac{\sigma q-1}{\sigma q}\right)} + (1-\delta_i) xd_i^{\left(\frac{\sigma q-1}{\sigma q}\right)} \right]^{\left(\frac{\sigma q}{\sigma q-1}\right)} \quad (15)$$

Relative demands $$\left(\frac{m}{xd}\right)_i = \left[\left(\frac{\delta}{1-\delta}\right)_i \left(\frac{pd}{pm}\right)_i \right]^{\sigma c} \quad (16)$$

Demand

Intermediate goods demand $$nd_i = \sum_j a_{i,j} x_j \quad (17)$$

Final consumption $$cd_{i,hh} = \gamma_{i,hh} + \Psi_{i,lc} \left[\frac{(1-\phi_{hh}) yd_{hh} - \sum_j pc_j (1+\tau_j^c) \gamma_{j,hh}}{pc_i (1+\tau_i^c)} \right] \quad (18)$$

Consumption share $$\Psi_{i,hh} = \frac{pc_i (1+\tau_i^c)^{(1-\sigma c)} \theta_{i,hh}^{\sigma c}}{\sum_j pc_j (1+\tau_j^c)^{(1-\sigma c)} \theta_{j,hh}^{\sigma c}} \quad (19)$$

Capital formation $$pk_i dk_i = \kappa_i (1+\nu(r_i - \bar{r}))\left[s - E\Delta Z - pk_{pub}(dk_{pub} + dkg) \right] \quad (20)$$

Investment $$id_i = \sum_j b_{i,j}[dk_i + dkg] \quad (21)$$

Government expenditure
$$g = (pva_{pub} + \sum_j a_{pub,j} pc_j)\bar{g} + \sum_{lc} \Phi_{pub,lc}.w_{lc}.L_{pub,lc} + \sum_i om_i(KG - KG_0) \quad (22)$$

Income and Saving

Rural Income $$y_{rur} = \sum_{ir} pva_{ir} x_{ir} \quad (23)$$

Urban unskilled $$y_{urbu} = \sum_{iu} wa_u \Phi_{iu,u} L_{iu,u} \quad (24)$$

Urban skilled $$y_{urbs} = \sum_{iu} pva_{iu} x_{iu} - y_{urbu} + i^d \bar{B} \quad (25)$$

Disposable income $$yd_{hh} = y_{hh}(1 - \tau^D_{hh}) + E.rmit_{hh} + trns_{hh} \quad (26)$$

Government revenue
$$tr = \sum_i \left[E\left(\tau^m_i \, pm^w_i m_i + \tau^e_i \, pe^w_i e_i \right) + \tau^c_i \, pc_i \sum_{hh} cd_{i,hh} \right] + \sum_{hh} \tau^D_{hh} y_{hh} \quad (27)$$

Household saving $$s_{hh} = \varphi_{hh} yd_{hh} \quad (28)$$

Government saving $$s_G = tr - g - \sum_{hh} trns_{hh} - i^d \bar{B} - Ei^f \bar{F} \quad (29)$$

Saving $$s = \sum_{hh} s_{hh} + s_G + E.aid \quad (30)$$

Equilibrium Conditions

Balance of payments $$\sum_i \left(pm^w_i m_i - pe^w_i e_i \right) + i^f \bar{F} = aid + \sum_{hh} rmit_{hh} + \Delta Z \quad (31)$$

Goods $$q_i = \sum_{hh} cd_{i,hh} + nd_i + id_i + \bar{g}_i + om_i(KG - KG_0) \quad (32)$$

Variables

E	exchange rate
pm^w	world price of imports
pm	domestic price of imports
pe^w	world price of exports
pe	domestic price of exports
pd	price of domestic good
pc	price of composite consumption good
px	output price
pva	value added price
pk	capital price (by destination)
pl	price of composite labour
w	nominal wage rate

Φ	wage distribution factor
τ^m	tariff rate
τ^e	export duty rate
τ^c	indirect tax rate
τ^d	direct tax rate
x	domestic output
q	composite supply
xd	domestic sales
e	exports
m	imports
H	land
LC	composite labour
L	skill-specific employment
$\bar{L}$	skill-specific labour supply
K	private capital stock
KG	public capital stock
a	input-output matrix
b	capital composition matrix
nd	intermediate demand
cd	final consumption demand
θ	consumption shares
γ	subsistence consumption
dk	private investment demand (by destination)
dkg	public investment demand (by destination)
id	investment demand (by origin)
r	sectoral profit rate
g	total government expenditure
$\bar{g}$	government consumption
om	marginal O&M rates
$rmit$	remittances
$trns$	budget transfers
y	gross factor income
yd	disposable income
s	saving
φ	propensity to save
tr	government revenue
i^d	domestic interest rate
i^f	foreign interest rate
$\bar{B}$	domestic debt stock
$\bar{F}$	external debt stock
Z	official reserves
aid	net aid flows
σl	elasticity of substitution (labour)
σt	elasticity of transformation(output)
σq	elasticity of substitution (demand)
σc	elasticity of substitution (consumption)