One approach to growth in open economies is to assume imports of capital or intermediate goods are imperfect substitutes for and therefore complement production inputs. Or they can be required in fixed proportions as in Gallup and Sachs (1999). The endogenous growth model used in Basu and Mcleod (1992) adds stochastic shocks to find terms of trace variability can reduce growth model, but at its core is very similar Barro's (1990) model of public investment. Assuming foreign capital F and domestic capital K are complements, we can assume balanced trade $pX = (1+\tau) F$ and set the export to GDP share arbitrarily at $X = \lambda Y$. Note that τ is the tariff collected on imported capital goods. Adding a tariff allows us to discuss the impact of trade policy on growth where $Y = AK^{\alpha}F^{\beta}$ and $\alpha + \beta = 1$ so that $\beta = 1- \alpha$. Countries pays for the services of foreign capital goods by exporting X at a price p determined in world markets also referred to at the net barter terms of trade, the relative price of exports over imports. Trade is balanced but an exogenous increase in the terms of trade raises growth while an increase in the tariff τ has the opposite effect, generally,

$$pX = (1+\tau)F \text{ so that } F = \left(\frac{1}{1+\tau}\right)pX.$$

The country imposes a tax τ on imported inputs thus raising the return to domestic capital goods. Although it will be possible to solve for the optimal export share, for now was assume the economy exports a fixed share of GDP, $X = \lambda Y$. Substituting for F and X in the production function yields,

$$Y = AK^{\alpha}\left(\frac{1}{1+\tau}\right)^{1-\alpha}(p\lambda)^{1-\alpha}\,Y^{1-\alpha} \text{ or } Y*Y^{-1+\alpha} = Y^{\alpha} = AK^{\alpha}\left(\frac{1}{1+\tau}\right)^{1-\alpha}(p\lambda)^{1-\alpha}$$

Raising both sides of this expression to $1/\alpha$ gets rid of the exponent on Y and K yielding modified A*K model where we use $\beta = 1 - \alpha$ to simplify the notation a bit,

$$Y = \left[A^{\frac{1}{\alpha}}\left(\frac{1}{1+\tau}\right)^{\frac{\beta}{\alpha}}(p\lambda)^{\frac{\beta}{\alpha}}\right]K \quad or \quad Y = A^{*}K \quad where \quad A^{*} = A^{\frac{1}{\alpha}}\left(\frac{1}{1+\tau}\right)^{\frac{\beta}{\alpha}}p^{\frac{\beta}{\alpha}}\lambda^{\frac{\beta}{\alpha}}$$

Note that A* now depends on the tariff and the terms of trade. An increase in the terms of trade p increases the growth rate while an increase in the tariff τ reduces the growth rate as A* declines. Basu and McLeod (1992) examine a similar growth model with a stochastic export price $p_t = \mu\varepsilon_t$ where ε_t is serially uncorrelated shock to export prices. When the share of domestic capital is greater than .5 ($\alpha > .5$) a rise in terms of trade variability measured by ε_t also lowers expected returns to investment (A*) and growth falls.

Challenge question: a) Plot the A* against the tariff rate τ against A* as in this spreadsheet. Does raising a tariff always reduce growth? b) Numerically, find the export to GDP share λ that maximizes A*. Do the same analytically following the strategy used to maximize c* in the answer to Jones Ex. 5 *Can we save too much?* That is set the derivative of λ w/r to A* =0 and solve for λ. Be sure to type up your answer in Word if you do the analytical part *Optional: Once you find the optimal value λ*numerically or analytically, explore how it depends on τ.*

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[1] Ali Zafar, World Bank Economist, documents the high cost of traveling from Burkina Faso to a port in Ghana see also "Defragmenting Africa" & "Let Africa trade with Africa." Anyone who has taken a "road trip" in Africa knows what they mean.

Figure 1 Changes in Growth Rates from Mileva and McLeod (2011)

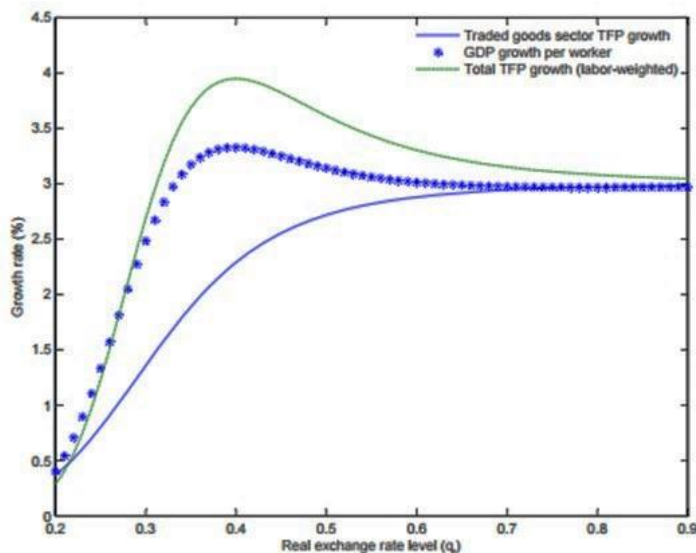

Figure 1: A real exchange rate driven shift of labor into traded goods creates a surge in TFP and GDP growth. (*Parameter values:* $\alpha = 0.8; \delta = 0.03; A_0 = 3; B = 1$)

Figure 2 Tariff rates and Growth from Rodriguez and Rodrik, 2000 p.271

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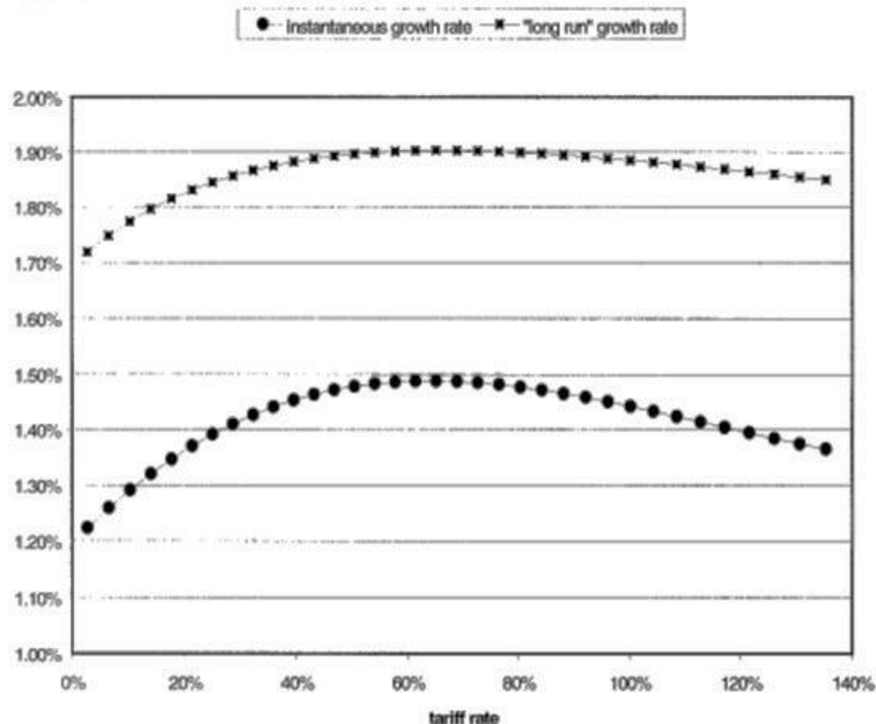
Figure 2 GROWTH RATES OF GDP AT WORLD PRICES



Using MS Word: (1) Select and Paste: use the Windows "snipping tool" to cut and paste a diagram into your answer **(2) reduce size, increase contrast:** Always cut as save image as jpg or windows metafile **(3) Number and add source:** select and then right to add "caption" which can be a Figure and a source as above, author, date, page if possible, then Figures or Tables from disparate sources can be labeled uniquely (important) and sequentially (less important).