Online Appendix to:

The Incidence of Tariffs: Rates and Reality

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In this Online Appendix, we derive the key theoretical results from Sections 3 and 8.1 of the main text.

A Tariff and Exchange Rate Pass-Through

The derivation of tariff pass-through follows closely the derivation of exchange rate pass-through in Burstein and Gopinath (2014).

We first consider the case of flexible prices. The dollar price in logs, p_F, at which an exporter sells goods to the US can be expressed generically as equal to the sum of its (log) mark-up and (log) marginal cost in dollars. We allow the mark-up to be a function of the relative price of the exporter's good in the US market, $p_F + \tau$, relative to an overall price index (log) p in the US. As discussed in Burstein and Gopinath (2014), several models with variable mark-ups can be expressed in this form. A firm's market-share varies with its relative price in the destination market, and in models with non-constant elasticity of demand this gives rise to variability in desired mark-ups.

For the marginal cost, as is standard, it can be expressed as a function of input prices, and of the quantity sold when marginal cost is variable. The quantity sold is in turn a function of the relative price of the firm's good in the destination market. The price of inputs include those costs like the wage rate in the exporter's country that tend to be sticky in local currency, w^*, and their dollar value depends on the exchange rate e. As most exporters use imported inputs whose prices are stable in dollars, only a fraction ϕ of the input costs are affected by the exchange rate.

$$p_F = \mu(\tau + p_F - p) + mc((\tau + p_F - p), e, w^*)$$

Taking a log-linear approximation around a symmetric price point with $\tau = e = 0$, we have

$$dp_F = -\Gamma(d\tau + dp_F - dp) - \Phi(d\tau + dp_F - dp) + \phi de \tag{A1}$$

Here $\Gamma \equiv -\frac{\partial \mu}{\partial(\tau+p_F-p)}$ and $\Phi = -\frac{\partial mc}{\partial q} \cdot \frac{\partial q}{\partial(\tau+p_F-p)}$. Γ captures the elasticity of the mark-up to the firm's relative price and Φ captures the elasticity of marginal cost to the relative price. The latter is a product of the extent of departure from constant returns to scale and the elasticity of demand for the exporter's good. Collecting terms,

$$dp_F = \frac{-\Gamma - \Phi}{1+\Gamma+\Phi} d\tau + \frac{\phi}{1+\Gamma+\Phi} de + \frac{\Gamma+\Phi}{1+\Gamma+\Phi} dp$$

Inclusive of tariff pass-through:

$$dp_F + d\tau = \frac{1}{1+\Gamma+\Phi} d\tau + \frac{\phi}{1+\Gamma+\Phi} de + \frac{\Gamma+\Phi}{1+\Gamma+\Phi} dp$$

In the paper we focus on the 'direct effect' which excludes the dp term. The direct effect is a good approximation when the destination market is large relative to the exporting country.

Next we consider the case when prices are reset infrequently with probability $(1-\kappa)$ à la Calvo. We consider the case when $\Gamma = \Phi = 0$. The reset price, $\bar{p}_{F,t}$ can be expressed as

$$\bar{p}_{F,t} = (1-\beta\kappa) \sum_{\ell=0}^{\infty} (\beta\kappa)^{\ell} E_t \left[\phi e_{t+\ell} + const.\right]$$

Suppose that the exchange rate is expected to evolve as AR(1) processes with persistent ρ_e, $e_t = \rho_e e_{t-1} + \epsilon_{e,t}$ Then it follows that

$$\bar{p}_{F,t} = (1-\beta\kappa) \cdot \frac{\phi e_t}{(1-\beta\kappa\rho_e)}$$

$$\bar{p}_{F,t} + \tau_t = \tau_t + \frac{(1-\beta\kappa)\phi}{(1-\beta\kappa\rho_e)} e_t, \tag{A2}$$

When expressed in deviations from the last price change we have,

$$d\bar{p}_{F,t} + d\tau_t = d\tau_t + \frac{(1-\beta\kappa)\phi}{(1-\beta\kappa\rho_e)} de_t, \tag{A3}$$

B Impact of Tariffs on the Exchange Rate

The trade balance equals the difference between the value of exports and the ex-tariff value of imports,

$$TB_t = P_H C_H^* - P_F C_F$$

where P_H is the dollar export price of the home good and C_H is the consumption of the home good in the foreign country. Similarly, P_F is the dollar import price and C_F is the consumption of foreign good at home. If the trade balance does not change, it must follow that the change in exports matches the change in imports.

Assuming a CES structure for demand at home with elasticity σ, the value of imports inclusive of tariffs satisfies the following relation,

$$(1+\tau)P_F C_F = \gamma \left(\frac{(1+\tau)P_F}{P} \right)^{1-\sigma} PC \tag{A4}$$

where P and C represent the overall price level and consumption level at home and γ captures the preference for imported goods. We assume P and C remain unchanged, which would be consistent with the importing country being large and mostly closed. Monetary policy is assumed to target a fixed P. Expressing (A4) in logs and linearizing around a zero trade balance point,

$$dp_F + dc_F + d\tau = (1-\sigma)(d\tau + dp_F)$$

$$dp_F + dc_F = -(\sigma - 1)dp_F - \sigma d\tau$$

Similarly, the demand in the foreign country for the home good is given by,

$$\frac{P_H C_H^*}{\varepsilon} = \gamma^* \left(\frac{P_H}{\varepsilon P^*} \right)^{1-\sigma} P^* C^*$$

where ε is the exchange rate in levels expressed as dollar per unit of foreign currency, γ^* captures preference for home goods in the foreign country. P^* and C^* are assumed fixed.

$$dp_H + dc_H^* - de = (1-\sigma)(dp_H - de)$$

$$dp_H + dc_H^* = (1-\sigma)dp_H + \sigma de = -(\sigma-1)dp_F - \sigma d\tau \tag{A5}$$

Recall equation (A1) (focusing on the direct effect so $dp = 0$)

$$dp_F = \frac{-(\Gamma+\Phi)}{1+\Gamma+\Phi}d\tau + \frac{\phi}{1+\Gamma+\Phi}de \tag{A6}$$

The pricing equation for the dollar export price is the same as for the dollar import price with the only difference that $\phi = 1$. This captures dollar dominance, that is for the US all of its production costs, including imported inputs, are in its home currency. Accordingly,

$$dp_H = \frac{(\Gamma+\Phi)}{1+\Gamma+\Phi}de \tag{A7}$$

Substituting equations (A6) and (A7) into (A5) we arrive at the exchange rate response to tariffs:

$$\frac{de}{d\tau} = \frac{\frac{\Gamma+\Phi}{1+\Gamma+\Phi} - \frac{\sigma}{\sigma-1}}{\frac{\phi-(\Gamma+\Phi)}{1+\Gamma+\Phi} + \frac{\sigma}{\sigma-1}} = \frac{-(\sigma+(\Gamma+\Phi))}{\phi(\sigma-1)+(\sigma+(\Gamma+\Phi))}$$