Appendix (for online publication)

A- Exact hat algebra: counterfactual equilibrium conditions

$\widehat{X}$ denotes the ratio of the new equilibrium value for variable X over the baseline value, i.e. $\widehat{X} = X'/X$. Therefore, $X\widehat{X}$ denotes the new equilibrium value for variable X.

- For income, we have:

  $$\widehat{E_n}E_n = \widehat{w_n}w_nL_n + \sum_g \widehat{r_{ng}}r_{ng}V_{ng}$$

  Hence:

  $$\widehat{E_n} = \frac{w_nL_n}{E_n}\widehat{w_n} + \sum_g \frac{r_{ng}V_{ng}}{E_n}\widehat{r_{ng}}$$

  we obtain the equation in the text by denoting: $e_{nL} = \frac{w_nL_n}{E_n}$ and $e_{ng} = \frac{r_{ng}V_{ng}}{E_n}$.

- CES Utility:

  $$\widehat{P^F_n}P^F_n = \left[\sum_k a_{nk}(\widehat{P^F_{nk}}P^F_{nk})^{1-\sigma}\right]^{\frac{1}{1-\sigma}}$$

  hence:

  $$\widehat{P^F_n} = \left[\sum_k a_{nk}\left(\frac{\widehat{P^F_{nk}}P^F_{nk}}{P^F_n}\right)^{1-\sigma}\right]^{\frac{1}{1-\sigma}}$$

  we obtain the equation in the text after noticing that $\alpha_{nk} = a_{nk}\left(\frac{P^F_{nk}}{P^F_n}\right)^{1-\sigma}$ is the expenditure share of good k in the baseline equilibrium.

- The same logic applies to the price index and trade shares:

  $$\widehat{P^F_{nk}} = \left[\sum_i \lambda^F_{nik}(\widehat{C^F_{ik}}\widehat{\tau_{nik}})^{-\theta_k}\right]^{-\frac{1}{\theta_k}}$$

  $$\widehat{P^C_{ng}} = \left[\sum_i \lambda^C_{nig}(\widehat{C^C_{ig}}\widehat{\tau_{nig}})^{-\theta_g}\right]^{-\frac{1}{\theta_g}}$$

  using trade shares $\lambda^F_{nik} = \frac{(C^F_{ik}\tau_{nik})^{-\theta_k}}{(P^F_{nk})^{-\theta_k}}$ and $\lambda^C_{nig} = \frac{(C^C_{ig}\tau_{nig})^{-\theta_g}}{P^C_{ng}{}^{-\theta_g}}$.

- Expenditure in final good k is such that:

  $$D^F_{nk}\widehat{D^F_{nk}} = a_{nk}\left(\frac{\widehat{P^F_{nk}}P^F_{nk}}{\widehat{P^F_k}P^F_n}\right)^{1-\sigma} E_n\widehat{E_n}$$

  hence:

  $$\widehat{D^F_{nk}} = \left(\frac{\widehat{P^F_{nk}}}{\widehat{P^F_k}}\right)^{1-\sigma}\widehat{E_n}$$

- For the cost of producing final good k in producing country i, we have:

  $$C^F_{ik}\widehat{C^F_{ik}} = A^F_{ik}\left[\beta^F_{ik,L}w_i^{1-\eta_k}\widehat{w}_i^{1-\eta_k} + \sum_g \beta^F_{ik,g}(P^C_{ig}\widehat{P^C_{ig}})^{1-\eta_k}\right]^{\frac{1}{1-\eta_k}}$$

which gives:

$$\widehat{C_{ik}^F} = \left[\frac{A_{ik}^{F\,1-\eta_k} \beta_{ik,L}^F w_i^{1-\eta_k}}{C_{ik}^{F\,1-\eta_k}} \widehat{w}_i^{\,1-\eta_k} + \sum_g \frac{A_{ik}^{F\,1-\eta_k} \beta_{ik,g}^F (P_{ig}^C)^{1-\eta_k}}{C_{ik}^{F\,1-\eta_k}} \widehat{P_{ig}^C}^{1-\eta_k} \right]^{\frac{1}{1-\eta_k}}$$

We obtain the equation in the text after noticing that $\varphi_{ik,L} = \frac{A_{ik}^{F\,1-\eta_k} \beta_{ik,L}^F w_i^{1-\eta_k}}{C_{ik}^{F\,1-\eta_k}}$ and $\varphi_{ik,g} = \frac{A_{ik}^{F\,1-\eta_k} \beta_{ik,g}^F (P_{ig}^C)^{1-\eta_k}}{C_{ik}^{F\,1-\eta_k}}$ are the cost shares of labor and commodity g respectively.

- We get a similar expression for the change in the cost for commodity g.
- Demand for commodity g in destination i, is:

  $$D_{ig}^C = \sum_k \beta_{ik,g}^F (P_{ig}^C / C_{ik}^F)^{1-\eta_k} \, Y_{ik}^F$$

  where $Y_{ik}^F = \sum_n X_{nik}^F$ denotes production of good k in i.
- Trade in good k, from i to n: in each equilibrium we have:

  $$X_{nik}^F = (C_{ik}^F \tau_{nik})^{-\theta_k} (P_{nk}^F)^{\theta_k} \, D_{nk}^F$$

  Hence:

  $$\widehat{X_{nik}^F} = (\widehat{C_{ik}^F} \widehat{\tau_{nik}})^{-\theta_k} (\widehat{P_{nk}^F})^{\theta_k} \, \widehat{D_{nk}^F}$$

  We obtain the change in production after noticing that:

  $$\widehat{Y_{ik}^F} = \sum_n (X_{nik}^F / Y_{ik}^F) \widehat{X_{nik}^F}$$

  where X_{nik}^F / Y_{ik}^F are exports to n as a share of total production in country i.
- Trade for commodity g, from i to n: similarly, in each equilibrium we have:

  $$X_{nig}^C = (C_{ig}^C \tau_{nig})^{-\theta_g} (P_{ng}^C)^{\theta_g} \, D_{ng}^C$$

  Hence:

  $$\widehat{X_{nig}^C} = (\widehat{C_{ig}^C} \widehat{\tau_{nig}})^{-\theta_g} (\widehat{P^C}_{ng})^{\theta_g} \, \widehat{D_{ng}^C}$$

  We obtain the change in production after noticing that:

  $$\widehat{Y_{ig}^C} = \sum_n (X_{nig}^C / Y_{ig}^C) \widehat{X_{nig}^C}$$

  where X_{nig}^c / Y_{ig}^C are exports to n as a share of total production in country i, and where $Y_{ig}^C = \sum_n X_{nig}^C$ denotes the production of commodity g in country i.
- Income from specific factor g satisfies:

  $$R_{ig} r_{ig} = \beta_{ig}^C (r_{ig} / C_{ig}^C)^{1-\rho_g} \, Y_{ig}^C$$

- Income from labor satisfies:

  $$L_i w_i = \sum_g (1 - \beta_{ig}^C)(w_i / C_{ig}^C)^{1-\rho_g} \, Y_{ig}^C \; + \; \sum_k \beta_{ik,L}^F (w_i / C_{ik}^F)^{1-\eta_k} \, Y_{ik}^F$$

  where Y_{ik}^F and Y_{ig}^C denote the production of final good k and commodity g respectively.

B- Closed-form solutions

Here we normalize $\hat{w}_i = 1$ for a given country i. We focus on the case where downstream and upstream substitution elasticities are equal, denoted by σ.

As described above, the change in production of commodity g is given by:

$$\widehat{Y_{ig}^{C}} = \widehat{P_{ig}^{C}}^{1-\sigma} \frac{D_{ig}^{C}}{Y_{ig}^{C}} \sum_{k} d_{nkg} \frac{\widehat{Y_{ik}^{F}}}{\widehat{C_{ik}^{F}}^{1-\sigma}}$$

In that case, it is then simple to express the change in income from specific factor r_{ig} as a function of the change in manufacturing prices and production. Using $\widehat{C_{ig}^{C}} = {\lambda_{ig}^{C}}^{\frac{1}{\theta_g}} \widehat{P_{ig}^{C}}$, we get:

$$\begin{aligned}
\hat{r}_{ig} &= \widehat{C_{ig}^{C}}^{-\frac{1-\sigma}{\sigma}} \widehat{Y_{ig}^{C}}^{\frac{1}{\sigma}} && (47)\\
&= {\lambda_{ig}^{C}}^{-\frac{1-\sigma}{\theta_g \sigma}} \widehat{P_{ig}^{C}}^{-\frac{1-\sigma}{\sigma}} \widehat{Y_{ig}^{C}}^{\frac{1}{\sigma}} && (48)\\
&= \left({\lambda_{ig}^{C}}^{-\frac{1-\sigma}{\theta_g}} \frac{D_{ig}^{C}}{Y_{ig}^{C}} \sum_{k} d_{nkg} \frac{\widehat{Y_{ik}^{F}}}{\widehat{C_{ik}^{F}}^{1-\sigma}} \right)^{\frac{1}{\sigma}} && (49)
\end{aligned}$$

The change in the cost of commodity g is then:

$$\begin{aligned}
\widehat{C_{ig}^{C}}^{1-\sigma} &= \varphi_{ig,L} + \varphi_{ig,R} \hat{r}_{ig}^{1-\sigma} && (50)\\
&= \varphi_{ig,L} + \varphi_{ig,R} \left({\lambda_{ig}^{C}}^{-\frac{1-\sigma}{\theta_g}} \frac{D_{ig}^{C}}{Y_{ig}^{C}} \sum_{k} d_{nkg} \frac{\widehat{Y_{ik}^{F}}}{\widehat{C_{ik}^{F}}^{1-\sigma}} \right)^{\frac{1-\sigma}{\sigma}} && (51)
\end{aligned}$$

Combining with $\widehat{P_{ig}^{C}} = {\lambda_{ig}^{C}}^{-\frac{1}{\theta_g}} \widehat{C_{ig}^{C}}$ and the equation above to describe the change in production, we obtain:

$$\begin{aligned}
\widehat{P_{ig}^{C}}^{1-\sigma} &= \varphi_{ig,L} {\lambda_{ig}^{C}}^{-\frac{1-\sigma}{\theta_g}} + \varphi_{ig,R} {\lambda_{ig}^{C}}^{-\frac{1-\sigma}{\theta_g}} \hat{r}_{ig}^{1-\sigma} && (52)\\
&= \varphi_{ig,L} {\lambda_{ig}^{C}}^{-\frac{1-\sigma}{\theta_g}} + \varphi_{ig,R} {\lambda_{ig}^{C}}^{-\frac{1-\sigma}{\theta_g}} \left({\lambda_{ig}^{C}}^{-\frac{1-\sigma}{\theta_g}} \frac{D_{ig}^{C}}{Y_{ig}^{C}} \sum_{k} d_{nkg} \frac{\widehat{Y_{ik}^{F}}}{\widehat{C_{ik}^{F}}^{1-\sigma}} \right)^{\frac{1-\sigma}{\sigma}} && (53)
\end{aligned}$$

and:

$$\begin{aligned}
\widehat{Y_{ig}^{C}} &= \widehat{C_{ig}^{C}}^{1-\sigma} \left({\lambda_{ig}^{C}}^{-\frac{1-\sigma}{\theta_g}} \frac{D_{ig}^{C}}{Y_{ig}^{C}} \sum_{k} d_{nkg} \frac{\widehat{Y_{ik}^{F}}}{\widehat{C_{ik}^{F}}^{1-\sigma}} \right) && (54)\\
&= \varphi_{ig,L} \left({\lambda_{ig}^{C}}^{-\frac{1-\sigma}{\theta_g}} \frac{\widehat{Y_{ik}^{F}}}{\widehat{C_{i}^{F}}^{1-\sigma}} \frac{D_{ig}^{C}}{Y_{ig}^{C}} \right) + \varphi_{ig,R} \left({\lambda_{ig}^{C}}^{-\frac{1-\sigma}{\theta_g}} \frac{D_{ig}^{C}}{Y_{ig}^{C}} \sum_{k} d_{nkg} \frac{\widehat{Y_{ik}^{F}}}{\widehat{C_{ik}^{F}}^{1-\sigma}} \right)^{\frac{1}{\sigma}} && (55)
\end{aligned}$$

For the cost of manufacturing $\widehat{C_{ik}^{F}}^{1-\sigma} = \varphi_{ik,L} + \sum_g \varphi_{ik,g} (\widehat{P_{ig}^{C}})^{1-\sigma}$, we get:

$$\widehat{C_{ik}^{F}}^{1-\sigma} = \varphi_{ik,L} + \sum_{g} \varphi_{ik,g} \varphi_{ig,L} {\lambda_{ig}^{C}}^{-\frac{1-\sigma}{\theta_g}} + \sum_{g} \varphi_{ik,g} \varphi_{ig,R} {\lambda_{ig}^{C}}^{-\frac{1-\sigma}{\theta_g}} \left({\lambda_{ig}^{C}}^{-\frac{1-\sigma}{\theta_g}} \frac{D_{ig}^{C}}{Y_{ig}^{C}} \sum_{h} d_{nhg} \frac{\widehat{Y_{ih}^{F}}}{\widehat{C_{ih}^{F}}^{1-\sigma}} \right)^{\frac{1-\sigma}{\sigma}}$$

$$= \quad \varphi_{ik,L} + \sum_g \varphi_{ik,g}\varphi_{ig,L}\lambda_{ig}^{C^{-\frac{1-\sigma}{\theta_g}}} + \sum_g \frac{\varphi_{ik,g}\varphi_{ig,R}Y^C_{ig}}{D^C_{ig}} \frac{\hat{r}_{ig}^{\frac{1}{\sigma}}}{\sum_h d_{nhg}\widehat{Y^F_{ih}}\widehat{C^F_{ih}}^{\sigma-1}}$$

Using $D^C_{ig}d_{ik,g} = \varphi_{ik,g}Y^F_{ik}$ and $e_{ig,R}E_i = \varphi_{ig,R}Y^C_{ig}$, we get:

$$\widehat{C^F_{ik}}^{1-\sigma} \quad = \quad \varphi_{ik,L} + \sum_g \varphi_{ik,g}\varphi_{ig,L}\lambda_{ig}^{C^{-\frac{1-\sigma}{\theta_g}}} + \sum_g \frac{E_i e_{ig,R}\hat{r}_{ig}^{\frac{1}{\sigma}}}{Y^F_{ik}} \frac{d_{ik,g}}{\sum_h d_{ih,g}\widehat{Y^F_{ih}}\widehat{C^F_{ih}}^{\sigma-1}}$$

Rearranging, and noticing that $\frac{\widehat{Y^F_{ik}}}{\widehat{C^F_{ik}}^{1-\sigma}} = \frac{D^F_{ik}}{Y^F_{ik}}\frac{\widehat{E_i}}{\widehat{P^F_i}^{1-\sigma}}\lambda_{ik}^{F^{-\frac{1-\sigma}{\theta_k}}}$, we obtain:

$$\begin{aligned}
Y^F_{ik}\widehat{Y^F_{ik}} &= \frac{Y^F_{ik}\widehat{Y^F_{ik}}}{\widehat{C^F_{ik}}^{1-\sigma}}\left[\varphi_{ik,L} + \sum_g \varphi_{ik,g}\varphi_{ig,L}\lambda_{ig}^{C^{-\frac{1-\sigma}{\theta_g}}}\right] + E_i\sum_g e_{ig,R}\hat{r}_{ig}^{\frac{1}{\sigma}} \frac{d_{nkg}\widehat{Y^F_{ik}}\widehat{C^F_{ik}}^{\sigma-1}}{\sum_h d_{nhg}\widehat{Y^F_{ih}}\widehat{C^F_{ih}}^{\sigma-1}} \\
&= \frac{\widehat{E_i}D^F_{ik}}{\widehat{P^F_i}^{1-\sigma}}\lambda_{ik}^{F^{-\frac{1-\sigma}{\theta_k}}}\left[\varphi_{ik,L} + \sum_g \varphi_{ik,g}\varphi_{ig,L}\lambda_{ig}^{C^{-\frac{1-\sigma}{\theta_g}}}\right] + E_i\sum_g e_{ig,R}\hat{r}_{ig}^{\frac{1}{\sigma}} \frac{d_{nkg}\widehat{Y^F_{ik}}\widehat{C^F_{ik}}^{\sigma-1}}{\sum_h d_{nhg}\widehat{Y^F_{ih}}\widehat{C^F_{ih}}^{\sigma-1}}
\end{aligned}$$

and summing across industries, we get:

$$E_i\widehat{E_i} = \sum_k Y^F_{ik}\widehat{Y^F_{ik}} = \sum_k \frac{\widehat{E_i}D^F_{ik}}{\widehat{P^F_i}^{1-\sigma}}\lambda_{ik}^{F^{-\frac{1-\sigma}{\theta_k}}}\left[\varphi_{ik,L} + \sum_g \varphi_{ik,g}\varphi_{ig,L}\lambda_{ig}^{C^{-\frac{1-\sigma}{\theta_g}}}\right] + E_i\sum_g e_{ig,R}\hat{r}_{ig}^{\frac{1}{\sigma}}$$

which can be rewritten:

$$\widehat{E_i} - \sum_g e_{ig,R}\hat{r}_{ig}^{\frac{1}{\sigma}} \quad = \quad \frac{\widehat{E_i}}{\widehat{P^F_i}^{1-\sigma}}\sum_k \alpha_{ik}\lambda_{ik}^{F^{-\frac{1-\sigma}{\theta_k}}}\left[\varphi_{ik,L} + \sum_g \varphi_{ik,g}\varphi_{ig,L}\lambda_{ig}^{C^{-\frac{1-\sigma}{\theta_g}}}\right]$$

The counterfactual equation describing the change in income provides: $\widehat{E_i} = e_{iL} + \sum_g e_{ig,R}\hat{r}_{ig}$. Combining with the equation above, we obtain:

$$\frac{\widehat{E_i}}{\widehat{P^F_i}^{1-\sigma}}\sum_k \alpha_{ik}\lambda_{ik}^{F^{-\frac{1-\sigma}{\theta_k}}}\left[\varphi_{ik,L} + \sum_g \varphi_{ik,g}\varphi_{ig,L}\lambda_{ig}^{C^{-\frac{1-\sigma}{\theta_g}}}\right] \; = \; e_{iL}$$

Hence:

$$\frac{\widehat{E_i}}{\widehat{P^F_i}^{1-\sigma}} \; = \; \Lambda_i^{\sigma-1}$$

where Λ_i is defined as:

$$\Lambda_i^{1-\sigma} \equiv \frac{1}{e_{iL}}\sum_k \alpha_k\lambda_{ik}^{F^{-\frac{1-\sigma}{\theta_k}}}\left[\varphi_{ik,L} + \sum_g \varphi_{ik,g}\varphi_{ig,L}\lambda_{ig}^{C^{-\frac{1-\sigma}{\theta_g}}}\right] \tag{56}$$

Plugging it back into 49, and using again $\frac{\widehat{Y^F_{ik}}}{\widehat{C^F_{ik}}^{1-\sigma}} = \frac{D^F_{ik}}{Y^F_{ik}}\frac{\widehat{E_i}}{\widehat{P^F_i}^{1-\sigma}}\lambda_{ik}^{F^{-\frac{1-\sigma}{\theta_k}}}$, we obtain an analytical expression for the change in income for natural resources:

$$\hat{r}_{ig} \quad = \quad \left(\lambda_{ig}^{C^{-\frac{1-\sigma}{\theta_g}}}\frac{D^C_{ig}}{Y^C_{ig}}\sum_k d_{nkg}\frac{\widehat{Y^F_{ik}}}{\widehat{C^F_{ik}}^{1-\sigma}}\right)^{\frac{1}{\sigma}}$$

$$\begin{aligned} &= \left(\frac{\widehat{E}_i}{\widehat{P_i^F}^{1-\sigma}}\right)^{\frac{1}{\sigma}} \left(\lambda_{ig}^{C^{-\frac{1-\sigma}{\theta_g}}} \frac{D_{ig}^C}{Y_{ig}^C} \sum_k \frac{d_{nkg} D_{ik}^F}{Y_{ik}^F} \lambda_{ik}^{F^{-\frac{1-\sigma}{\theta_k}}}\right)^{\frac{1}{\sigma}} \\ &= \left(\lambda_{ig}^{C^{-\frac{1-\sigma}{\theta_g}}} \frac{1}{\Lambda_i^{1-\sigma}} \frac{D_{ig}^C}{Y_{ig}^C} \sum_k \frac{d_{nkg} D_{ik}^F}{Y_{ik}^F} \lambda_{ik}^{F^{-\frac{1-\sigma}{\theta_k}}}\right)^{\frac{1}{\sigma}} \end{aligned}$$

Next, using again the counterfactual equation describing the change in income, we obtain the change in GDP:

$$\begin{aligned} \widehat{E}_i &= e_{iL} + \sum_g e_{ig,R} \hat{r}_{ig} \\ &= e_{iL} + \sum_g e_{ig,R} \left(\lambda_{ig}^{C^{-\frac{1-\sigma}{\theta_g}}} \frac{e_{iL}}{\Lambda_i^{1-\sigma}} \frac{D_{ig}^C}{Y_{ig}^C} \sum_k \frac{d_{nkg} D_{ik}^F}{Y_{ik}^F} \lambda_{ik}^{F^{-\frac{1-\sigma}{\theta_k}}}\right)^{\frac{1}{\sigma}} \end{aligned}$$

For the price index of manufacturing goods, we get:

$$\begin{aligned} \widehat{P_i^F}^{1-\sigma} &= \widehat{E}_i \, \Lambda_i^{1-\sigma} \\ &= \Lambda_i^{1-\sigma} \left[e_{iL} + \sum_g e_{ig,R} \hat{r}_{ig} \right] \\ \widehat{P_i^F} &= \Lambda_i \left[e_{iL} + \sum_g e_{ig,R} \left(\lambda_{ig}^{C^{-\frac{1-\sigma}{\theta_g}}} \frac{1}{\Lambda_i^{1-\sigma}} \frac{D_{ig}^C}{Y_{ig}^C} \sum_k \frac{d_{nkg} D_{ik}^F}{Y_{ik}^F} \lambda_{ik}^{F^{-\frac{1-\sigma}{\theta_k}}}\right)^{\frac{1}{\sigma}} \right]^{\frac{1}{1-\sigma}} \end{aligned}$$

Finally, we obtain that the gains from trade are:

$$\begin{aligned} GT_i = \frac{\widehat{P_i^F}}{\widehat{E}_i} &= \Lambda_i \left[e_{iL} + \sum_g e_{ig,R} \left(\lambda_{ig}^{C^{-\frac{1-\sigma}{\theta_g}}} \frac{1}{\Lambda_i^{1-\sigma}} \frac{D_{ig}^C}{Y_{ig}^C} \sum_k \frac{d_{nkg} D_{ik}^F}{Y_{ik}^F} \lambda_{ik}^{F^{-\frac{1-\sigma}{\theta_k}}}\right)^{\frac{1}{\sigma}} \right]^{\frac{\sigma}{1-\sigma}} \\ &= \left[\Lambda_i^{\frac{1-\sigma}{\sigma}} + \sum_g e_{ig,R} \left(\lambda_{ig}^{C^{-\frac{1-\sigma}{\theta_g}}} \frac{D_{ig}^C}{Y_{ig}^C} \sum_k \frac{d_{nkg} D_{ik}^F}{Y_{ik}^F} \lambda_{ik}^{F^{-\frac{1-\sigma}{\theta_k}}}\right)^{\frac{1}{\sigma}} \right]^{\frac{\sigma}{1-\sigma}} \end{aligned}$$

Two special cases An interesting and practical case is to assume that is there only one downstream industry, $k = M$ (manufacturing industry). In that case, the formula describing the gains from trade simplifies to:

$$GT_i = \lambda_{iM}^{-\frac{1}{\theta_M}} \left[e_{iL} \left(\frac{\varphi_{iM,L} + \sum_g \varphi_{iM,g} \varphi_{ig,L} \lambda_{ig}^{C^{-\frac{1-\sigma}{\theta_g}}}}{e_{iL}} \right)^{\frac{1}{\sigma}} + \sum_g e_{ig,R} \left(\lambda_{ig}^{C^{-\frac{1-\sigma}{\theta_g}}} \frac{E_i}{Y_i^F} \frac{D_{ig}^C}{Y_{ig}^C} \right)^{\frac{1}{\sigma}} \right]^{\frac{\sigma}{1-\sigma}} \tag{57}$$

This case is easier to calibrate as it requires less information on input-output links between upstream and downstream industries.

Another interesting special case is to assume that all primary commodities are homogeneous goods. This corresponds to taking the limit $\theta_g \to +\infty$. In this case, the expression for the gains from trade is the same but now we can see that Λ_i and $\hat{r}_{ig}$ satisfy:

$$\Lambda_i^{1-\sigma} \equiv \sum_k \alpha_k \varphi_{ik,L}^{tot} \lambda_{ik}^{F^{-\frac{1-\sigma}{\theta_k}}} \qquad \text{and} \qquad \hat{r}_{ig} = \left(\frac{1}{\Lambda_i^{1-\sigma}} \frac{D_{ig}^C}{Y_{ig}^C} \sum_k \frac{d_{nkg} D_{ik}^F}{Y_{ik}^F} \lambda_{ik}^{F^{-\frac{1-\sigma}{\theta_k}}} \right)^{\frac{1}{\sigma}} \tag{58}$$

where $\varphi^{tot}_{ik,L}$ denotes the total requirement in labor for the production of final goods k in i, computed using the domestic input-output matrix: $\varphi^{tot}_{ik,L} = \varphi_{ik,L} + \sum_{g \in G(k)} \varphi_{ik,g}\varphi_{ig,L}$.

In particular, if commodities are homogeneous goods ($\theta_g = +\infty$) and if there is only one downstream industry (manufacturing), we get:

$$GT_i \; = \; \lambda_{iM}^{-\frac{1}{\theta_M}} \left[e_{iL} \left(\frac{\varphi^{tot}_{iM,L}}{e_{iL}} \right)^{\frac{1}{\sigma}} + \sum_g e_{ig,R} \left(\frac{E_i}{Y^F_i} \frac{D^C_{ig}}{Y^C_{ig}} \right)^{\frac{1}{\sigma}} \right]^{\frac{\sigma}{1-\sigma}} \tag{59}$$

C - Alternative model specifications

Choke prices. With the alternative production function of downstream industries specified in Section 3.4.1, the cost and demand for labor and commodities correspond to:

$$\begin{aligned}
C^F_{ik} &= \left[\beta^F_{ik,L} w_i^{1-\eta_k} + \sum_g \beta^F_{ik,g} \Big((P^C_{ig})^{1-\eta_k} - (1-\eta_k) P^C_{ig} (a_{ig} w_i)^{-\eta_k} \Big) \right]^{\frac{1}{1-\eta_k}} \\
D^C_{igk} &= \beta^F_{ik,g} \Big((P^C_{ig})^{1-\eta_k} - (a_{ig} w_i)^{-\eta_k} P^C_{ig} \Big) \cdot \frac{Y^F_{ik}}{{C^F_{ik}}^{1-\eta_k}} \\
w_i L_{igk} &= \left[\beta^F_{ik,L} w_i^{1-\eta_k} + \eta_k \sum_g \beta^F_{ik,g} P^C_{ig} (a_{ig} w_i)^{-\eta_k} \right] \cdot \frac{Y^F_{ik}}{{C^F_{ik}}^{1-\eta_k}}
\end{aligned}$$

In this case, note that the share of commodity g in costs is now:

$$\varphi_{ik,g} = \frac{\partial \log C^F_{ik}}{\partial \log P^C_{ig}} = \frac{\beta^F_{ik,g} P^C_{ig} \Big((P^C_{ig})^{-\eta_k} - (a_{ig} w_i)^{-\eta_k} \Big)}{{C^F_{ik}}^{1-\eta_k}}$$

while the share of labor is:

$$\varphi_{ik,L} = \frac{\partial \log C^F_{ik}}{\partial \log w_i} = \frac{\beta^F_{ik,L} w_i^{1-\eta_k}}{{C^F_{ik}}^{1-\eta_k}} + \eta_k \sum_g \frac{\beta^F_{ik,g} P^C_{ig} (a_{ig} w_i)^{-\eta_k}}{{C^F_{ik}}^{1-\eta_k}}$$

Now the counterfactual change in downstream costs corresponds to:

$$\begin{aligned}
\widehat{C^F_{ik}}^{1-\eta_k} &= \frac{\beta^F_{ik,L} w_i^{1-\eta_k} \widehat{w_i}^{1-\eta_k}}{{C^F_{ik}}^{1-\eta_k}} + \sum_g \left[\frac{\beta^F_{ik,g} (P^C_{ig})^{1-\eta_k} \widehat{P^C_{ig}}^{1-\eta_k}}{{C^F_{ik}}^{1-\eta_k}} - \frac{(1-\eta_k) \beta^F_{ik,g} P^C_{ig} (a_{ig} w_i)^{-\eta_k} \widehat{P^C_{ig}} \hat{w}_i^{-\eta_k}}{{C^F_{ik}}^{1-\eta_k}} \right] \\
&= \varphi_{ik,L} \hat{w}_i^{1-\eta_k} + \sum_g \varphi_{ik,g} \widehat{P^C_{ig}}^{1-\eta_k} + \sum_g \frac{\beta^F_{ik,g} P^C_{ig} (a_{ig} w_i)^{-\eta_k}}{{C^F_{ik}}^{1-\eta_k}} \left[\widehat{P^C_{ig}}^{1-\eta_k} - \eta_k \hat{w}_i^{1-\eta_k} - (1-\eta_k) \widehat{P^C_{ig}} \hat{w}_i^{-\eta_k} \right] \\
&= \varphi_{ik,L} \hat{w}_i^{1-\eta_k} + \sum_g \varphi_{ik,g} \widehat{P^C_{ig}}^{1-\eta_k} + \sum_g \frac{\varphi_{ik,g} \Delta_{ig}}{1 - \Delta_{ig}} \left[\widehat{P^C_{ig}}^{1-\eta_k} - \eta_k \hat{w}_i^{1-\eta_k} - (1-\eta_k) \widehat{P^C_{ig}} \hat{w}_i^{-\eta_k} \right]
\end{aligned}$$

Note that $\frac{\beta^F_{ik,g} P^C_{ig} (a_{ig} w_i)^{-\eta_k}}{{C^F_{ik}}^{1-\eta_k}} = \varphi_{ik,g} \, \frac{(a_{ig} w_i)^{-\eta_k}}{(P^C_{ig})^{-\eta_k} - (a_{ig} w_i)^{-\eta_k}} = \varphi_{ik,g} \, \frac{\Delta_{ig}}{1-\Delta_{ig}}$

For the counterfactual change in the demand in commodity g, we get:

$$\widehat{D^C_{ngk}} \;\; = \;\; \left(\frac{(P^C_{ig})^{-\eta_k} \widehat{P^C_{ng}}^{-\eta_k} - (a_{ig} w_i)^{-\eta_k} \widehat{w_i}^{-\eta_k}}{(P^C_{ig})^{-\eta_k} - (a_{ig} w_i)^{-\eta_k}} \right) \frac{\widehat{P^C_{ng}} \, \widehat{Y^F_{nk}}}{\widehat{C^F_{nk}}^{1-\eta_k}} \tag{60}$$

$$= \left(\frac{1 - \Delta_{ig} (\widehat{P^C_{ng}} / \widehat{w}_i)^{\eta_k}}{1 - \Delta_{ig}} \right) \frac{\widehat{P^C_{ng}}^{1-\eta_k} \widehat{Y^F_{nk}}}{\widehat{C^F_{nk}}^{1-\eta_k}} \tag{61}$$

Note that $\Delta_{ig} (\widehat{P^C_{ng}} / \widehat{w}_i)^{\eta_k}$ must remain smaller than unity, i.e. the counterfactual price must remain below the choke price.

From labor demand, denoting by s^L_{ig} and s^L_{ik} the share of labor hired in the production of commodity g and final good k, we now get:

$$\begin{aligned}
\hat{w}_i &= \sum_g \frac{s^L_{ig} \widehat{Y^C_{ig}} \hat{w}_i^{1-\rho_g}}{\widehat{C^C_{ig}}^{1-\rho_g}} + \sum_k s^L_{i,k} \left(\frac{\beta^F_{ik,L} w_i^{1-\eta_k} + \eta_k \sum_g \beta^F_{ik,g} P^C_{ig} (a_{ig} w_i)^{-\eta_k} \widehat{P^C_{ng}} / \hat{w}_i}{\beta^F_{ik,L} w_i^{1-\eta_k} + \eta_k \sum_g \beta^F_{ik,g} P^C_{ig} (a_{ig} w_i)^{-\eta_k}} \right) \frac{\hat{w}_i^{1-\eta_k} \widehat{Y^F_{ik}}}{\widehat{C^F_{ik}}^{1-\eta_k}} \\
&= \sum_g \frac{s^L_{ig} \widehat{Y^C_{ig}} \hat{w}_i^{1-\rho_g}}{\widehat{C}_{ig}^{1-\rho_g}} + \sum_k s^L_{i,k} \left(1 + \eta_k \sum_g \frac{\varphi_{ik,g} (a_{ig} w_i)^{-\eta_k}}{\varphi_{ik,L} \Big((P^C_{ig})^{-\eta_k} - (a_{ig} w_i)^{-\eta_k} \Big)} \frac{\widehat{P^C_{ng}}}{\hat{w}_i} \right) \frac{\hat{w}_i^{1-\eta_k} \widehat{Y^F_{ik}}}{\widehat{C^F_{ik}}^{1-\eta_k}} \\
&= \sum_g \frac{s^L_{ig} \widehat{Y^C_{ig}} \hat{w}_i^{1-\rho_g}}{\widehat{C}_{ig}^{1-\rho_g}} + \sum_k s^L_{i,k} \frac{\hat{w}_i^{1-\eta_k} \widehat{Y^F_{ik}}}{\widehat{C^F_{ik}}^{1-\eta_k}} + \sum_{k,g} \frac{\eta_k s^L_{i,k} \varphi_{ik,g} \Delta_{ig}}{\varphi_{ik,L} (1 - \Delta_{ig})} \frac{\widehat{P^C_{ng}} \hat{w}_i^{-\eta_k} \widehat{Y^F_{ik}}}{\widehat{C^F_{ik}}^{1-\eta_k}}
\end{aligned}$$

Land allocation with constant elasticity of transformation. Suppose that country i is endowed with land T_i, which can be used to produce commodity g with productivity A_{ig}.

$$\sum_g (Q_{ig} / A_{ig})^{\frac{1+\rho}{\rho}} = T_i^{\frac{1+\rho}{\rho}}$$

Maximizing income from land (C_{ig} is the producer price for commodity g):

$$\sum_g C_{ig} Q_{ig}$$

leads to:

$$Y_{ig} = C_{ig} Q_{ig} = \mu_i (Q_{ig} / A_{ig})^{\frac{1+\rho}{\rho}}$$

where μ_i denotes the Lagrance multiplier associated with the constraint above. Rewriting, we get:

$$Q_{ig} = \mu_i^{-\rho} A_{ig}^{1+\rho} C_{ig}^{\rho}$$

and:

$$(Q_{ig} / A_{ig})^{\frac{1+\rho}{\rho}} = \mu_i^{-(1+\rho)} A_{ig}^{-\frac{1+\rho}{\rho} + \frac{(1+\rho)^2}{\rho}} C_{ig}^{1+\rho} = \mu_i^{-(1+\rho)} A_{ig}^{1+\rho} (P^C_{ig})^{1+\rho}$$

Taking the sum, we obtain:

$$T_i^{\frac{1+\rho}{\rho}} = \sum_g (Q_{ig} / A_{ig})^{\frac{1+\rho}{\rho}} = \sum_g \mu_i^{-(1+\rho)} A_{ig}^{1+\rho} C_{ig}^{1+\rho} \qquad \Longrightarrow \qquad \mu_i^{1+\rho} = \sum_g A_{ig}^{1+\rho} C_{ig}^{1+\rho} T_i^{-\frac{1+\rho}{\rho}}$$

which leads to the expression in the main text after substituting μ_i.

Closed-form solution with CET for the gains from trade relative to autarky.

$$\widehat{C_{ig}} = \widehat{\Phi}_i^{\frac{\rho}{1+\rho}} \widehat{Y_{ig}}^{\frac{1}{1+\rho}}$$

combined with:

$$\widehat{Y_{ig}} = \widehat{C_{ig}}^{1-\sigma} \lambda_{ig}^{C^{-\frac{1-\sigma}{\theta_g \sigma}}} \frac{D_{ig}^C}{Y_{ig}^C} \sum_k d_{nkg} \frac{\widehat{Y_{ik}^F}}{\widehat{C_{ik}^F}^{1-\sigma}}$$

leads to:

$$\widehat{C_{ig}} = \widehat{\Phi}_i^{\frac{\rho}{\rho+\sigma}} \left(\lambda_{ig}^{C^{-\frac{1-\sigma}{\theta_g}}} \frac{D_{ig}^C}{Y_{ig}^C} \sum_k d_{nkg} \frac{\widehat{Y_{ik}^F}}{\widehat{C_{ik}^F}^{1-\sigma}} \right)^{\frac{1}{\rho+\sigma}}$$

Plugging it back into the expression for Φ_i, we obtain:

$$\widehat{\Phi}_i^{\frac{\sigma(1+\rho)}{\rho+\sigma}} = \sum_g \pi_{ig}^T \left(\lambda_{ig}^{C^{-\frac{1-\sigma}{\theta_g}}} \frac{D_{ig}^C}{Y_{ig}^C} \sum_k d_{nkg} \frac{\widehat{Y_{ik}^F}}{\widehat{C_{ik}^F}^{1-\sigma}} \right)^{\frac{1+\rho}{\rho+\sigma}}$$

In turn, for the cost of downstream industries, we obtain

$$\begin{aligned}
\widehat{C_{ik}^F}^{1-\sigma} &= \varphi_{ik,L} + \sum_g \varphi_{ik,g} (\widehat{P_{ig}^C})^{1-\sigma} = \varphi_{ik,L} + \sum_g \varphi_{ik,g} \lambda_{ig}^{C^{-\frac{1-\sigma}{\theta_g}}} \widehat{C_{ig}}^{1-\sigma} \\
&= \varphi_{ik,L} + \widehat{\Phi}_i^{\frac{\rho(1-\sigma)}{\rho+\sigma}} \sum_g \varphi_{ik,g} \lambda_{ig}^{C^{-\frac{1-\sigma}{\theta_g}}} \left(\lambda_{ig}^{C^{-\frac{1-\sigma}{\theta_g}}} \frac{D_{ig}^C}{Y_{ig}^C} \sum_k d_{nkg} \frac{\widehat{Y_{ik}^F}}{\widehat{C_{ik}^F}^{1-\sigma}} \right)^{\frac{1-\sigma}{\rho+\sigma}}
\end{aligned}$$

With $\widehat{P_i^F}^{1-\sigma} = \sum_k \alpha_{ik} \lambda_{ik}^{F^{-\frac{1-\sigma}{\theta_k}}} \widehat{C_{ik}^F}^{1-\sigma}$, we get:

$$\begin{aligned}
\widehat{P_i^F}^{1-\sigma} &= \sum_k \alpha_{ik} \varphi_{ik,L} \lambda_{ik}^{F^{-\frac{1-\sigma}{\theta_k}}} + \widehat{\Phi}_i^{\frac{\rho(1-\sigma)}{\rho+\sigma}} \sum_{k,g} \alpha_{ik} \varphi_{ik,g} \lambda_{ik}^{F^{-\frac{1-\sigma}{\theta_k}}} \lambda_{ig}^{C^{-\frac{1-\sigma}{\theta_g}}} \left(\lambda_{ig}^{C^{-\frac{1-\sigma}{\theta_g}}} \frac{D_{ig}^C}{Y_{ig}^C} \sum_k d_{nkg} \frac{\widehat{Y_{ik}^F}}{\widehat{C_{ik}^F}^{1-\sigma}} \right)^{\frac{1-\sigma}{\rho+\sigma}} \\
&= \sum_k \alpha_{ik} \varphi_{ik,L} \lambda_{ik}^{F^{-\frac{1-\sigma}{\theta_k}}} + \widehat{\Phi}_i^{\frac{\rho(1-\sigma)}{\rho+\sigma}} \sum_{k,g} \frac{\alpha_{ik} \varphi_{ik,g} Y_{ig} \lambda_{ik}^{F^{-\frac{1-\sigma}{\theta_k}}}}{D_{ig}^C \sum_k d_{nkg} \widehat{Y_{ik}^F} \widehat{C_{ik}^F}^{\sigma-1}} \left(\lambda_{ig}^{C^{-\frac{1-\sigma}{\theta_g}}} \frac{D_{ig}^C}{Y_{ig}^C} \sum_k d_{nkg} \frac{\widehat{Y_{ik}^F}}{\widehat{C_{ik}^F}^{1-\sigma}} \right)^{\frac{1+\rho}{\rho+\sigma}}
\end{aligned}$$

Using $D_{ig}^C d_{igk} = \varphi_{ik,g} Y_{ik}^F$ and $e_{ig,R} E_i = Y_{ig}^C$ and $\alpha_{ik} E_i$, we get:

$$\widehat{P_i^F}^{1-\sigma} = \sum_k \alpha_{ik} \varphi_{ik,L} \lambda_{ik}^{F^{-\frac{1-\sigma}{\theta_k}}} + \widehat{\Phi}_i^{\frac{\rho(1-\sigma)}{\rho+\sigma}} \sum_{k,g} \frac{D_{ik}^F \, d_{ik,g} e_{ig,R} \lambda_{ik}^{F^{-\frac{1-\sigma}{\theta_k}}}}{Y_{ik} \sum_k d_{nkg} \widehat{Y_{ik}^F} \widehat{C_{ik}^F}^{\sigma-1}} \left(\lambda_{ig}^{C^{-\frac{1-\sigma}{\theta_g}}} \frac{D_{ig}^C}{Y_{ig}^C} \sum_k d_{nkg} \frac{\widehat{Y_{ik}^F}}{\widehat{C_{ik}^F}^{1-\sigma}} \right)^{\frac{1+\rho}{\rho+\sigma}}$$

Rearranging, and noticing that $\widehat{Y_{ik}^F} \widehat{C_{ik}^F}^{\sigma-1} = \frac{D_{ik}^F}{Y_{ik}^F} \widehat{E}_i \widehat{P_i^F}^{\sigma-1} \lambda_{ik}^{F^{-\frac{1-\sigma}{\theta_k}}}$, we obtain:

$$\begin{aligned}
\widehat{E}_i &= \widehat{E}_i \widehat{P_i^F}^{\sigma-1} \sum_k \alpha_{ik} \varphi_{ik,L} \lambda_{ik}^{F^{-\frac{1-\sigma}{\theta_k}}} + \widehat{\Phi}_i^{\frac{\rho(1-\sigma)}{\rho+\sigma}} \sum_g e_{ig,R} \left(\lambda_{ig}^{C^{-\frac{1-\sigma}{\theta_g}}} \frac{D_{ig}^C}{Y_{ig}^C} \sum_k d_{nkg} \frac{\widehat{Y_{ik}^F}}{\widehat{C_{ik}^F}^{1-\sigma}} \right)^{\frac{1+\rho}{\rho+\sigma}} \\
&= \widehat{E}_i \widehat{P_i^F}^{\sigma-1} \sum_k \alpha_{ik} \varphi_{ik,L} \lambda_{ik}^{F^{-\frac{1-\sigma}{\theta_k}}} + e_{iR} \widehat{\Phi}_i
\end{aligned}$$

Using $\widehat{E}_i = e_{iL} + e_{i,R} \widehat{\Phi}_i$, we obtain:

$$\widehat{E}_i \widehat{P_i^F}^{\sigma-1} = \Lambda_i^{\sigma-1}$$

where Λ_i is defined as:

$$\Lambda_i^{1-\sigma} \equiv \frac{1}{e_{iL}} \sum_k \alpha_{ik} \varphi_{ik,L} {\lambda_{ik}^F}^{-\frac{1-\sigma}{\theta_k}}$$

Plugging it back into the expression for $\widehat{\Phi}_i$, and using again $\frac{\widehat{Y_{ik}^F}}{\widehat{C_{ik}^F}^{1-\sigma}} = \frac{D_{ik}^F}{Y_{ik}^F} \frac{\widehat{E}_i}{\widehat{P_i^F}^{1-\sigma}} {\lambda_{ik}^F}^{-\frac{1-\sigma}{\theta_k}} = \Lambda_i^{\sigma-1} \frac{D_{ik}^F}{Y_{ik}^F} {\lambda_{ik}^F}^{-\frac{1-\sigma}{\theta_k}}$, we obtain an analytical expression for the change in income for natural resources:

$$\widehat{\Phi}_i = \left[\sum_g \pi_{ig}^T \left(\frac{{\lambda_{ig}^C}^{-\frac{1-\sigma}{\theta_g}}}{\Lambda_i^{1-\sigma}} \frac{D_{ig}^C}{Y_{ig}^C} \sum_k d_{nkg} {\lambda_{ik}^F}^{-\frac{1-\sigma}{\theta_k}} \frac{D_{ik}^F}{Y_{ik}^F} \right)^{\frac{1+\rho}{\rho+\sigma}} \right]^{\frac{\rho+\sigma}{\sigma(1+\rho)}}$$

Change in income is then:

$$\widehat{E}_i \quad = \quad e_{iL} + e_{i,R} \widehat{\Phi}_i \;=\; e_{iL} + e_{i,R} \left[\sum_g \pi_{ig}^T \left(\frac{{\lambda_{ig}^C}^{-\frac{1-\sigma}{\theta_g}}}{\Lambda_i^{1-\sigma}} \frac{D_{ig}^C}{Y_{ig}^C} \sum_k d_{nkg} {\lambda_{ik}^F}^{-\frac{1-\sigma}{\theta_k}} \frac{D_{ik}^F}{Y_{ik}^F} \right)^{\frac{1+\rho}{\rho+\sigma}} \right]^{\frac{\rho+\sigma}{\sigma(1+\rho)}}$$

For the final goods price index, we get:

$$\widehat{P_i^F}^{1-\sigma} \quad = \quad \widehat{E}_i \, \Lambda_i^{1-\sigma} \;=\; \Lambda_i^{1-\sigma} \left[e_{iL} + e_{i,R} \widehat{\Phi}_i \right]$$

Finally, we obtain that the gains from trade are:

$$\begin{aligned}
GT_i \quad &= \quad \frac{\widehat{P_i^F}}{\widehat{E}_i} \;=\; \frac{\widehat{P_i^F}}{\widehat{E}_i^{\frac{1}{1-\sigma}}} \widehat{E}_i^{\frac{\sigma}{1-\sigma}} \;=\; \Lambda_i \widehat{E}_i^{\frac{\sigma}{1-\sigma}} \\
&= \quad \Lambda_i \left\{ e_{iL} + e_{i,R} \left[\sum_g \pi_{ig}^T \left(\frac{{\lambda_{ig}^C}^{-\frac{1-\sigma}{\theta_g}}}{\Lambda_i^{1-\sigma}} \frac{D_{ig}^C}{Y_{ig}^C} \sum_k d_{nkg} {\lambda_{ik}^F}^{-\frac{1-\sigma}{\theta_k}} \frac{D_{ik}^F}{Y_{ik}^F} \right)^{\frac{1+\rho}{\rho+\sigma}} \right]^{\frac{\rho+\sigma}{\sigma(1+\rho)}} \right\}^{\frac{\sigma}{1-\sigma}} \\
&= \quad \left\{ e_{iL} \Lambda_i^{\frac{1-\sigma}{\sigma}} + e_{i,R} \left[\sum_g \pi_{ig}^T \left({\lambda_{ig}^C}^{-\frac{1-\sigma}{\theta_g}} \frac{D_{ig}^C}{Y_{ig}^C} \sum_k d_{nkg} {\lambda_{ik}^F}^{-\frac{1-\sigma}{\theta_k}} \frac{D_{ik}^F}{Y_{ik}^F} \right)^{\frac{1+\rho}{\rho+\sigma}} \right]^{\frac{\rho+\sigma}{\sigma(1+\rho)}} \right\}^{\frac{\sigma}{1-\sigma}}
\end{aligned}$$

D - Survey of Elasticity Estimates

Short Run Elasticity Estimates

Commodity	PED	PES	Location	Citation
Alfalfa	-0.107	0.44	California	Russo et al. (2008)
Almonds	-0.48 to -0.35	0.19	California	Russo et al. (2008)
Aluminium	-0.07	0.17	Germany, France, Italy, UK	Blomberg and Hellmer (2000)
Aluminium	-0.7		12 Countries	Stuermer (2017)
Aluminium	-0.2			Charles River Associates (1971), reviewed by Varon and Takeuchi (1974)
Aluminium	-0.6524		World	Evans and Lewis (2002)
Aluminium		0.117	World	Choe (1990)
Aluminium	-0.27	0.05	OECD	Hojman (1981)
Aluminium			World	J. Behrman (1975)
Aluminium		1.15	US	Connelly and Perlman (1975)
Bananas		(0.2 to 0.4)		Borrell and Hanslow (2004), reviewed by Jenkins (2011)
Bananas	(-0.738 to -0.566)		UK	Tiffin et al. (2011)
Barley	(-0.41 to -0.14)	0.12	EU	Food and Agricultural Policy Research Institute (2017)
Chromium	-0.2771		World	Evans and Lewis (2002)
Chromium	-0.1		Review of other studies	Radetzki (1984)
Citrus	(-0.994 to -0.804)		UK	Tiffin et al. (2011)
Coal		0.0565		Labys et al. (1979)
Coal	(-0.7 to -0.3)		China, 2012	Burke and Liao (2015)
Cobalt	-0.0287		United States	Gupta and Gupta (1983)
Cobalt	-0.5		Review of other studies	Radetzki (1984)
Cobalt		<1	World	Sibley (1980)
Cobalt	(-0.24 to -0.09)	(0.21 to 0.25)	World	Rafati (1984a)
Cocoa	(-.14 to -.01)		UK, US, France	J. R. Behrman (1965)
Cocoa			World	Adams and Behrman (1976)
Cocoa		(0.03 to 0.12)	Review of other studies	Askari and Cummings (1977)
Coffee	-0.2		US	Okunade (1992)
Coffee		(0.1 to 0.28)	Review of other studies	Askari and Cummings (1977)
Coffee	(-0.54 to -0.07)	(0.02 to 0.55)	World	Akiyama and Varangis (1990)
Copper			World	Pobukadee (1980), reviewed by Slade (1992)
Copper	-0.42		United States	MacKinnon and Olewiler (1980)
Copper	-0.4		12 Countries	Stuermer (2017)
Copper		1.2	United States	Foley and Clark (1981)
Copper		0.453	World	Fisher et al. (1972)
Copper		0.116		Choe (1990)
Copper			World	J. Behrman (1975)
Copper		0.77	US	Connelly and Perlman (1975)
Copper	(-0.0972 to -0.0346)	(0.06 to 0.23)	World	Wagenhals (1983)
Copper	(-0.39 to -0.221)			Banks (1974)
Corn	(-0.44 to -0.24)	0.08	EU	Food and Agricultural Policy Research Institute (2017)
Corn		(0.124 to 0.574)	World	Haile et al. (2016)
Corn	(-0.287 to -0.244)	(0.207 to 0.270)	World	Roberts and Schlenker (2013)
Cotton	-0.684	0.497	California	Russo et al. (2008)
Crude Oil	(-0.05 to -0.003)	<0	World	M. N. Krichene (2005)
Crude Oil	(-0.08 to -0.02)	(<0 to 0.01)	World	N. Krichene (2002)
Crude Oil	-0.0752	0.289	US, 1990-2009	Coyle et al. (2012)
Crude Oil		0.09		Hogan (1989), reviewed by Dahl and Duggan (1996)
Ethanol	(-3.606 to -2.08)	0.121	US	Luchansky and Monks (2009)
Gold	-0.4115		World	Evans and Lewis (2002)
Iron	-0.0865		World	Evans and Lewis (2002)
Iron		0.589	World	Damuth (2011)
Iron			World	Priovolos (1987)
Iron			OECD	Hashimoto and Sihsobhon (1981)
Lead	-0.22		12 Countries	Stuermer (2017)
Lead	-0.1108		World	Evans and Lewis (2002)
Lead			World	Fisher et al. (1972), reviewed by Sigman (2004)
Lead			US	Sigman (1995)
Lead		1.84	US	Connelly and Perlman (1975)
Lead		0.109		Choe (1990)
Manganese	-0.1		Review of other studies	Radetzki (1984)
Manganese		>1		Brooks (1966)
Mercury	≈-0.1	1	Summary of CRA studies	Burrows (1974)
Natural Gas	(-0.39 to -0.08)	(<0 to 0.06)	World	N. Krichene (2002)

Notes: Many elasticity estimates of agricultural products from the Food and Agricultural Policy Research Institute (FAPRI) have been omitted from this table, although we use these to generate a range of elasticity estimates in Table 2 in the main section.

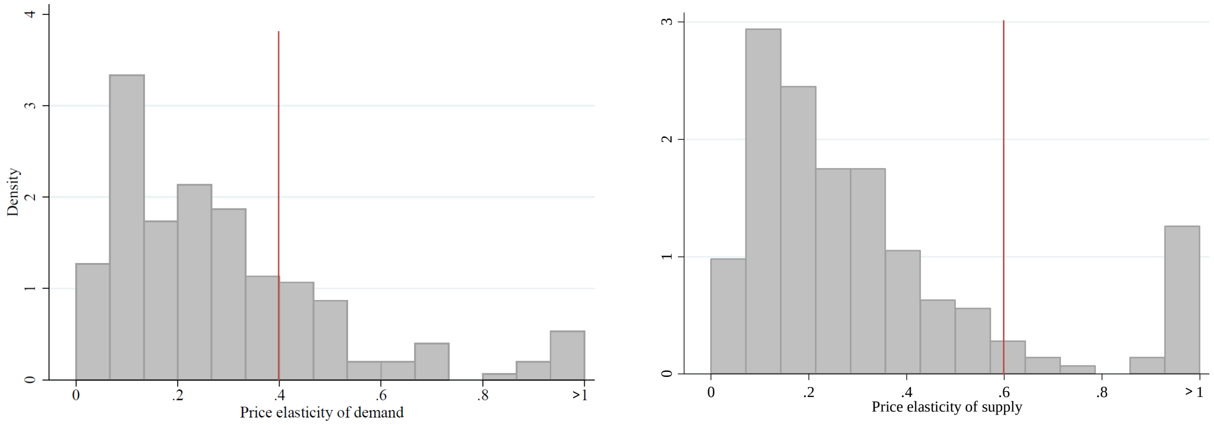
Short Run Elasticity Estimates (Continued)

Commodity	PED	PES	Location	Citation
Natural Gas		(0.014 to 0.15)		Barret (1992), reviewed by Dahl and Duggan (1996)
Natural Gas	(-0.95 to -0.053)		Review of Literature	Al-Sahlawi (1989)
Natural Gas	(-0.23 to -0.17)		California	Auffhammer and Rubin (2018)
Nickel	-0.0376		World	Evans and Lewis (2002)
Nickel		(0.356 to 1.28)	World	Rafati (1984b)
Nickel		2.03	US	Connelly and Perlman (1975)
Nickel		0.133		Choe (1990)
Niobium	-0.2946		World	Evans and Lewis (2002)
Niobium	-0.3		Review of other studies	Radetzki (1984)
Palladium	-0.2		Summary of CRA studies	Burrows (1974)
Peanuts	(-0.3 to -0.1)	(0.04 to 0.4)	Various	Food and Agricultural Policy Research Institute (2017)
Petroleum	(-0.31 to -0.22)		Literature Review	Dahl and Sterner (1991)
Petroleum	-0.23		Median of Reviewed Studies	Espey (1998)
Petroleum	-0.44		World	Kilian and Murphy (2014)
Petroleum	(-0.077 to -0.034)		US, Years 2001-2006	Hughes et al. (2008)
Petroleum	(-0.34 to -0.21)		US, Years 1975-1980	Hughes et al. (2008)
Platinum	-0.7		Summary of CRA studies	Burrows (1974)
Platinum	-0.28		World	Evans and Lewis (2002)
Pulse grains	(-0.71 to -0.339)	0.1695	India	Kumar et al. (2010), Kumar et al. (2011)
Rapeseed	(-0.3 to -0.08)	(0.26 to 0.36)	Various	Food and Agricultural Policy Research Institute (2017)
Rice	(-0.487 to -0.161)	0.2357	India	Kumar et al. (2010), Kumar et al. (2011)
Rice		(0.134 to 0.302)	China, India	Haile et al. (2016)
Rice	-0.14	(0.18 to 0.23)	California	Russo et al. (2008)
Rice	(-0.017 to 0.007)	(0.032 to 0.048)	World	Roberts and Schlenker (2013)
Roots	(-0.737 to -0.635)		UK	Tiffin et al. (2011)
Silver	-0.0423		World	Evans and Lewis (2002)
Sorghum	(-0.49 to -0.3)	0.53	Argentina	Food and Agricultural Policy Research Institute (2017)
Soybeans		(0.061 to 0.609)	World	Haile et al. (2016)
Soybeans	(-0.175 to -0.05)	(0.32 to 0.45)	World	Food and Agricultural Policy Research Institute (2017)
Soybeans		0.53	Brazil	Williams and Thompson (1984)
Soybeans	(-0.329 to -0.236)	(0.554 to 0.705)	World	Roberts and Schlenker (2013)
Sugar	-0.13	0.14	Australia	Food and Agricultural Policy Research Institute (2017)
Sugar			World	Adams and Behrman (1976)
Sugar	(-0.643 to -0.010)	0.1216	India	Kumar et al. (2010), Kumar et al. (2011)
Tin	-0.169		12 Countries	Stuermer (2017)
Tin	-0.55		United States	Banks (1972)
Tin	-0.0968		World	Evans and Lewis (2002)
Tin	(-0.49 to -0.11)	(0.21 to 1.11)	World	Chhabra et al. (1979)
Tin		0.032		Choe (1990)
Tin			World	J. Behrman (1975)
Titanium	-0.1602		World	Evans and Lewis (2002)
Tomatoes	-0.32	0.27	California	Russo et al. (2008)
Tomatoes	(-0.723 to -0.648)		UK	Tiffin et al. (2011)
Tungsten	-0.5		Review of other studies	Radetzki (1984)
Tungsten			Rest of World	Tan (1977)
Tungsten	-0.15	0.15	Summary of CRA studies, US	Burrows (1974)
Tungsten	-0.15	0.11	Summary of CRA studies, ROW	Burrows (1974)
Uranium		(1.1 to 4.3)	Review of Literature	Schneider and Sailor (2008)
Uranium		11.4	US	Connelly and Perlman (1975)
Vanadium	-0.2537		World	Evans and Lewis (2002)
Vanadium	-0.3		Review of other studies	Radetzki (1984)
Walnuts	(-0.267 to -0.251)	0.02	California	Russo et al. (2008)
Wheat	(-0.33 to -0.26)	0.12	EU	Food and Agricultural Policy Research Institute (2017)
Wheat	(-1.6 to -0.3)	0.2164	India	Kumar et al. (2010), Kumar et al. (2011)
Wheat		(0.103 to 0.355)	World	Haile et al. (2016)
Wheat	(-0.109 to -0.095)	(0.059 to 0.1)	World	Roberts and Schlenker (2013)
Zinc	-0.064		12 Countries	Stuermer (2017)
Zinc	-0.0635		World	Evans and Lewis (2002)
Zinc		0.085	World	Choe (1990)
Zinc		1.75	US	Connelly and Perlman (1975)
Zinc	-0.47		World	J. Behrman (1975)

Long Run Elasticity Estimates

Commodity	PED	PES	Location	Citation
Aluminium	-1.35			Charles River Associates (1971), reviewed by Varon and Takeuchi (1974)
Aluminium	-0.45	0.073	OECD	Hojman (1981)
Aluminium		0.37	World	J. Behrman (1975)
Coal		0.11		Labys et al. (1979)
Cobalt	-0.456		United States	Gupta and Gupta (1983)
Cobalt	(-0.54 to -0.43)	(0.35 to 0.44)	World	Rafati (1984a)
Cocoa	(-0.63 to -0.13)	0.33	World	Adams and Behrman (1976)
Cocoa		(0.15 to 0.38)	Review of other studies	Askari and Cummings (1977)
Coffee	-0.339		US	Okunade (1992)
Coffee		(0.11 to 0.6)	Review of other studies	Askari and Cummings (1977)
Coffee		(0.13 to 0.95)	World	Akiyama and Varangis (1990)
Copper		0.87	World	Pobukadee (1980), reviewed by Slade (1992)
Copper		≈6	United States	Foley and Clark (1981)
Copper	-0.51	1.67	World	Fisher et al. (1972)
Copper	(-0.82 to -0.12)		World	J. Behrman (1975)
Copper	(-0.421 to -0.328)			Banks (1974)
Cotton		.0503	California	Russo et al. (2008)
Crude Oil	(-0.32 to -0.26)	(0.12 to 0.46)	World	M. N. Krichene (2005)
Crude Oil	(-0.13 to -0.005)	(0.1 to 1.1)	World	N. Krichene (2002)
Crude Oil		0.58		Hogan (1989), reviewed by Dahl and Duggan (1996)
Iron	-0.48	0.24	World	Priovolos (1987)
Iron	-0.81		OECD	Hashimoto and Sihsobhon (1981)
Lead		(0.31 to 0.33)	World	Fisher et al. (1972), reviewed by Sigman (2004)
Lead		(0.27 to 0.81)	US	Sigman (1995)
Mercury	-1	3	Summary of CRA studies	Burrows (1974)
Natural Gas	(-1.1 to -0.7)	(0.28 to 0.8)	World	N. Krichene (2002)
Natural Gas	(-4.6 to -0.39)		Review of Literature	Al-Sahlawi (1989)
Nickel	(-1.22 to -0.1)	(1.2 to 5.5)	World	Rafati (1984b)
Palladium	(-1 to -.4)		Summary of CRA studies	Burrows (1974)
Petroleum	(-1.01 to -0.8)		Literature Review	Dahl and Sterner (1991)
Petroleum	-0.43		Median of Reviewed Studies	Espey (1998)
Platinum	(-2.8 to -1.3)		Summary of CRA studies	Burrows (1974)
Sugar	(-0.47 to -0.03)	(0.15 to 0.71)	World	Adams and Behrman (1976)
Tin	-1.262		United States	Banks (1972)
Tin	(-1.6 to -0.41)	(0.7 to 2.09)	World	Chhabra et al. (1979)
Tin		0.18	World	J. Behrman (1975)
Tomatoes		0.403	California	Russo et al. (2008)
Tungsten		0.3932	Rest of World	Tan (1977)
Tungsten	-0.3	0.95	Summary of CRA studies, US	Burrows (1974)
Tungsten	-0.37	0.5	Summary of CRA studies, ROW	Burrows (1974)
Walnuts		0.08	California	Russo et al. (2008)
Zinc		0.08	World	J. Behrman (1975)

Figure 13: Meta-distribution of price elasticity of supply



(a) Demand elasticities

(b) Supply elasticities

E - List of primary commodities under consideration

Table 9: List of primary commodities under consideration (calibration)

Alliums
Aluminium
Antimony
Arsenic
Asbestos
Bananas
Barley
Barytes & Strontium
Berries
Beryl
Bismuth
Borates
Brassicas
Bromine
Buckwheat & Millet
Cadmium
Cement
Chromium
Citruses
Coal
Cobalt
Cocoa
Coconuts
Coffee
Copper
Cotton
Crude Oil
Diamond
Diatomite
Feldspar
Flax
Fluorspar
Gallium et al. (*)
Germanium
Gold
Grapes
Graphite
Gypsum
Hops
Iodine
Iron
Jute
Lead
Legumes
Lithium
Magnesium
Maize
Manganese
Melons
Mercury
Mica
Molybdenum
Natural Gas
Natural gums
Natural rubber
Nickel
Niobium et al. (*)
Nuts
Oats
Other vegetables
Palm oil
Peanuts
Phosphate
Platinum Group
Pome fruit
Potash
Potatoes
Prunus fruit
Potatoes
Prunus fruit
Ramie
Rare Earths
Rice
Roots & tubers
Rye
Salt
Sand and gravel
Seeds
Selenium
Sillimanite
Silver
Sorghum
Soy beans
Spices
Sugar
Talc
Tea
Tellurium
Tin
Titanium
Tobacco
Tomatoes
Tropical fruit
Tungsten
Uranium
Vermiculite
Wheat
Wollastonite
Zinc
Zirconium

Niobium et al. is Niobium, Tantalum, and Vanadium.
Gallium et al. is Gallium, Indium, Rhenium, Thallium.

F - Data Description and Construction Notes

Below we describe the sources and procedure used to generate the data in our paper. We believe that this dataset may be of use to other researchers studying commodity trade, so we provide our data online at http://are.berkeley.edu/ fally/data.html, and intend to keep this information updated. When assembling commodity statistics on production, prices, and trade, the data are often reported at different levels of aggregation, and so we describe the associated difficulties of this below. We attempt to aggregate these data to the most precise level possible, and provide correspondence tables between the various sources of data used in the paper.

Production data. The British Geological Survey (2015) provides world mineral production statistics at the country level from 1913 to 2015, which is the main source of mineral production data.[28] The production data can be found online at the BGS website and is provided by the Natural Environment Research Council. For many commodities, the information is organized at the commodity level, but provided at the "subcommodity" level. For instance, "Titanium" is reported as Struverite, Titanium slag, Ilmenite, Rutile, Leucoxene, and simply as Titanium. In many of these cases, we sum production at the subcommodity level up to the commodity level, however in some cases, we use this information to aggregate the production data to a different commodity.

The main source of agricultural production data is FAOSTAT, provided by the Statistics Division of the Food and Agriculture Organization of the United Nations (2017), which provides data from 1960 to 2014 on the production of primary and processed agricultural products at the country level, which is also used by Costinot and Donaldson 2012 and Costinot et al. (2016).[29] The FAO provides correspondence tables for conversion of its own product classification to the 1996 version of the Harmonized Classification system, which we then use to create a correspondence of our own to the HS 1992 nomenclature.

Supplementally, we employ production data from the Global Trade Analysis Project, or GTAP version 8 (Aguiar et al. 2012), which provides production (in terms of value) data at the industrial sector level by country for 2007. While these data is mostly used in the calibration to provide the output of downstream industries (such as Motor Vehicles, Electronic Equipment, etc.), in a few cases we use the data to provide information regarding the output of primary commodities. We use GTAP production statistics for unrefined sugar, paddy rice, wheat, coal, crude oil, and natural gas in our calibration for 2007.[30]

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[28] From 1960 to 2015, this information is available in spreadsheet format, earlier years are available only in PDF format. The US Geological Survey also provides mineral production data at the country level, however we do not use this because, as to our knowledge, the data provided by USGS are available only for 2001-2014 in spreadsheet format. Where data are available to compare, in many cases, the USGS and BGS production data match, and when they don't, the differences are often minor. As it is difficult to say whether one source is more precise than the other, we prioritize the BGS production data.

[29] FAOSTAT also provides information regarding the production of livestock and animal products which we do not use, as it is difficult to argue that livestock requires natural resources as concentrated as those required in the production of minerals and other agricultural products.

[30] We do not include GTAP production statistics in the data we provide online. For these commodities we provide the data supplied by the BGS and FAO, which seems to be similar, although somewhat less reliable for a few outliers, mainly developing countries.

Trade data. Trade information comes from the BACI database, constructed by CEPII and based on UN-Comtrade data (Gaulier and Zignago 2010), and provided at the 6-digit level of the Harmonized Commodity Description and Coding System (HS). We use the HS 1992 nomenclature, as it provides the longest series, covering the years 1995 to 2014 (as of writing). Since the commodity lithium is not classified in the HS 1992 nomenclature, we use HS 1996 data to provide trade information for lithium. In order to match production and trade data, we further aggregate the trade data to match the level of granularity in the production data.

Data Aggregation We provide online a correspondence table between our aggregation codes and trade data, in addition to providing production, price, and input-output data used in the paper. For all these scattered sources, we try to remain as close as possible to the Harmonized Classification System (HS). When aggregating directly to a six digit HS code is not possible, we use a simple notation. We use the letter "A" (potentially followed by several zeroes) to denote that all listed HS6 products starting with the numbers before "A" are aggregated into this code. For instance, the aggregation code 3104A0 (Potash) includes the six digit codes 310410, 310420, and 310430, and any other codes starting with 3104 (only 310490, in this case). The letter "X" indicates that the aggregate code contains a selection of HS six digit products. For instance, our aggregation code 0810X0 (Berries) includes the six digit HS codes 081020 and 081040, but not the six digit code 081010 (Strawberries). However, any code containing either "A" or "X" may also contain additional six digit HS codes, when the level of production data requires aggregation above the HS four digit level, which should be noted. In the cases where aggregation is required, we compute production value at the most disaggregated level (that is, the level that prices are provided at), and aggregate this value, rather than aggregating quantities. It is for this reason that the data we provide online are slightly more disaggregated than the data we use in our baseline calibration; we provide data at the level at which we can provide informative quantity information. We provide a correspondence between the more disaggregated data we provide online and our baseline specification online.

Price data. The United States Geological Survey provides the Historical Statistics for Mineral and Material Commodities database (Kelly and Matos 2014), which catalogs prices of mineral commodities in the United States from 1900 to the present, and is the most comprehensive source of yearly price data available for minerals. One shortcoming of the database is that it does not cover mineral prices for countries other than the US.[31] One potential option to address this is by using export unit values from trade data instead as a proxy for producer prices. This route has well known shortcomings: unit values are frequently noisy, we find very large ranges in these values across countries, and observe occasional massive yearly spikes in unit values not reflected in the USGS price data that seem unlikely. These issues are most pronounced for developing countries.

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[31] By applying world prices to mineral production throughout the world, we are essentially assuming that minerals are fully homogenous, or that the trade elasticity is very large. While this is certainly not accurate, it is a more plausible assumption for minerals than other traded goods (although many authors have found that the trade elasticity is generally not higher for agriculture or commodities as a whole, Caliendo and Parro (2015) find evidence of a higher trade elasticity for minerals and petroleum). Further, in the text we demonstrate that our results are less sensitive to magnifications of the trade elasticity than in standard models, and in our context, it seems unlikely that having country specific prices would alter the estimates for the gains from trade very much. In other contexts, this would likely be a larger limitation.

Further, since the trade data must often be aggregated to match the production data, it is unclear whether the use of quantity information in such settings makes sense. Using unit values from the trade data is often problematic – resulting in many observations where the value of production of one or more commodities we observe exceeds GDP for the same time period. Reassuringly, we find that except for the aforementioned deviations and outliers, the USGS price data generally track fluctuations in unit values quite well, especially for large, developed countries.

One remaining difficulty is that the prices in the Mineral and Material Commodities database are for refined minerals, rather than for primary commodities such as ores. Therefore, using prices directly from the database would result in production values of minerals far higher than the actual value of production in those cases, especially for countries where refining of primary commodities produced domestically is done abroad. To address this, we "downscale" commodities based on United States export unit values, which generally look similar to the trends in the USGS price data.[32] A scaling factor, β, is chosen to minimize the sum of squared distance between the USGS price and the unit value price for a given commodity, so long as that scaling factor is less than one. To give a concrete example, to give a price to the production of Chromium Ore (the unrefined primary ore), we scale the price given for Smelted Chromium (a refined secondary product) by the US export unit value for Chromium Ores (HS code 261000), which results in assigning a price for producers of chromium ores as $\beta = .368$ times the price for refined Chromium. Since one would expect that changes in demand for processed metals affect demand for their primary ores in similar ways, this should imply that prices for primary commodities have similar trends, but lower overall levels. Indeed, looking at the US unit values for primary and processed mineral commodities for the small number of commodities we use this procedure on, this seems to be the case (in total, we perform this procedure for primary ores and unprocessed products of Asbestos, Aluminum, Antimony, Boron, Chromium, Cobalt, Copper, Gold, Iodine, Lead, Magnesite, Manganese, Molybdenum, Nickel, Silver, Tin, Titanium, Tungsten, and Zinc). Of these commodities, there are only six commodities for which we need to aggregate trade data to match the level of production, avoiding concerns about the suitability of aggregating quantities of trade. For the remaining six (Beryl, Boron, Copper, Molybdenum, Platinum, Rare Earth Minerals), we find that unit values from exports still follow the USGS prices closely. Figures 14 plot the comparison of US export prices and USGS prices per ton for a selection of commodities we perform this procedure on.

The USGS price data do not contain any information on uranium and fuels prices, so these data are complemented by the International Monetary Fund (IMF) Primary Commodity Price Series database for monthly uranium prices (which we aggregate up to yearly prices) (Commodities Team of the Research Department, IMF 2017), the World Bank Commodity "Pink Sheets" for petroleum and coal prices (World Bank Group 2017), and data from the U.S. Energy Information Association (2017) (EIA) on the producer (wellhead) price of natural gas, all of which are in current US dollars.

For agricultural products, FAOSTAT provides yearly country-level agricultural price data. This information is listed at the same level as the production data, and only aggregate these data after computing the production value of each commodity at level of aggregation the FAO provides. Although the FAO provides price information for many commodities in terms of current US dollars, often the prices are provided in terms of local currency units. When available, we prioritize the

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[32] We could downscale commodities using country specific scaling factors as well, but the concern again is how reliable unit values are for reporters that are developing countries.

prices as listed in terms of US dollars, supplemented by an exchange rate table for each country provided by the IMF-IFS database. Many commodities listed in the FAOSTAT are missing country level price information, for which we replace with the world median price.[33] In some cases, the producer price of a given commodity in one country can be almost 1,000 times as large as the median world price. These cases seem highly unlikely to reflect prices that producers would receive on the world market, and strongly inflate the value of production of these commodities, resulting in cases where the production value of a commodity exceeds reported GDP. Therefore, we omit country price data for commodities that are 50 times greater than the median world price, replacing these cases with the median world price.[34]

Commodity end use. GTAP provides information on the use of broad commodity sectors by downstream industrial sectors. We employ GTAP information to provide country level end-usage data for agricultural commodities and fuel products. However, as GTAP aggregates mineral commodities into only 2 categories, we combine it with USGS end-use data (Barry et al. 2015) for minerals. The USGS end-use data provide information on the relative use of mineral commodities by NAICS industry in the United States. We then match each NAICS code to the GTAP industrial classification system manually, and use this to match each commodity to the intensity of usage by each downstream GTAP industrial sector. Occasionally, the USGS data do not provide the relative frequency of mineral end-use by NAICS downstream sector for some commodities. However, the USGS still provides information on the NAICS downstream sectors that use the commodity, just not the relative proportions across industries. In these cases, we use the relative end use frequencies across downstream sectors for the respective commodity category from GTAP, but renormalize these frequencies by removing downstream industries not mentioned as using the commodity by the USGS. In the case of three commodities in our baseline calibration, there is more than one end use table for each "commodity" we use. For instance, "Platinum Group Metals" uses end use tables for Platinum, Palladium, Rhodium, and Iridium; "Vermiculite" uses end use tables for Vermiculite and Perlite, and "Niobium et al." uses end use tables for Vanadium and Tantalum. In such cases, we take a weighted average of these respective end use tables, where the weights are computed as the worldwide production value in 2007 for each end use mineral over the value of all constituent minerals in a commodity. This results in zero weights for Vermiculite, Rhodium, and Iridium, within "Niobium et al." the Vanadium end use table receives a weight of 0.84 and the Tantalum table has a weight of 0.16. Within "Platinum Group Metals", Platinum receives a weight of 0.6, Palladium receives a weight of 0.4, the remaining minerals have zero weights since they have zero production value in 2007.

Other Data Additionally, for our simulations, we employ GDP, natural resource rents, and value added data provided by The World Bank (2017).

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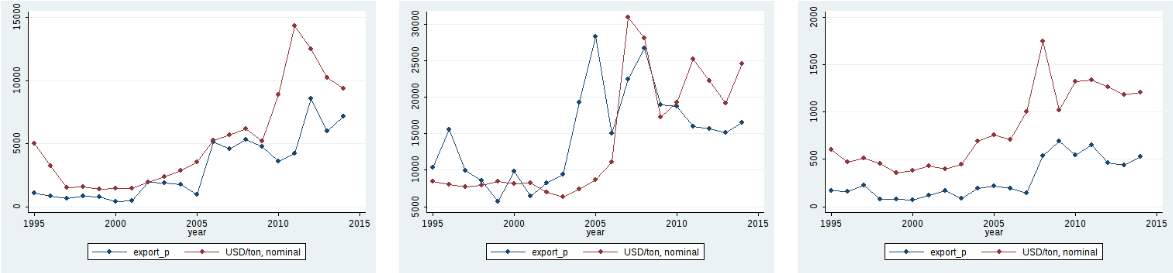
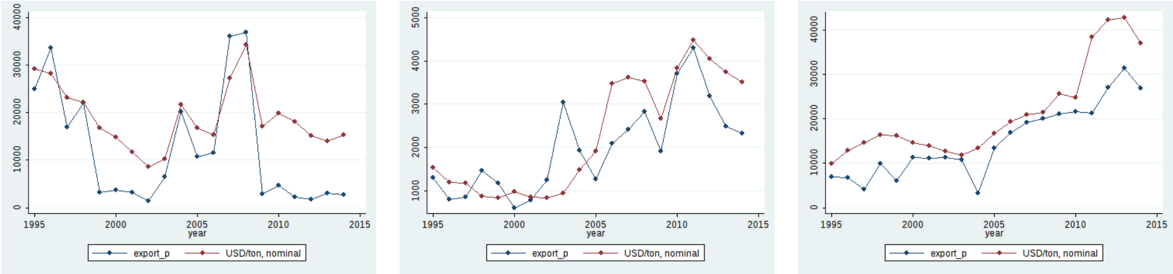
[33] We use the median price because in several cases there are outlying prices that bias the prices strongly upward.

[34] We have also tried replacing world prices with regional averages, however unfortunately in some regions there may be only one price, so averaging will bias all prices for a region upwards.

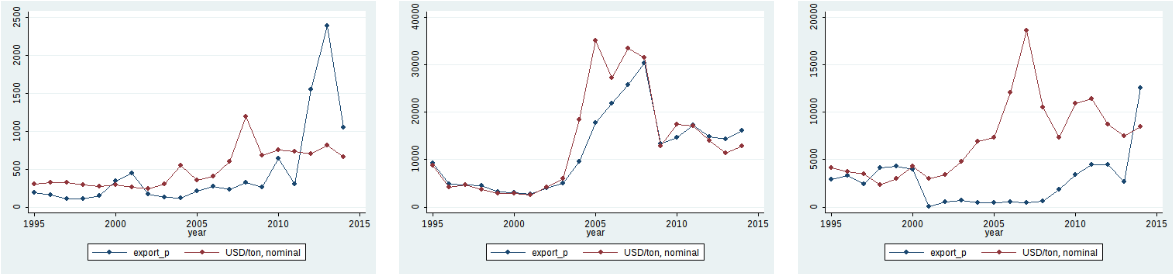
Figure 14: Comparison of USGS prices and US export prices (Red line is USGS provided price, blue is US export unit value, in USD per ton)



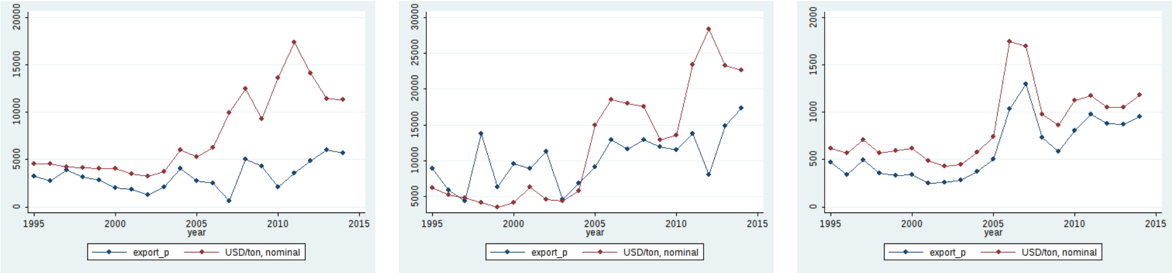
(a) Antimony (b) Bismuth (c) Chromium



(d) Cobalt (e) Copper (f) Iodine



(g) Manganese (h) Molybdenum (i) Nickel



(j) Tin (k) Tungsten (l) Zinc

Using gravity to fill in zeros in autarky counterfactuals

In section 4.1, we describe the issues presented when a country has positive demand for a commodity but no domestic production for measuring the gains from trade when considering full movements back to autarky. To partially address these concerns, we use predicted bilateral trade and production instead for autarky counterfactuals. Ideally, we would estimate the following equation for each commodity using PPML:

$$\begin{aligned}\log X_{nig} = \quad & FX_{ig} + FM_{ng} + \beta_{Dist,g}\log Dist_{ni} + \beta_{Contig,g}Contig_{ni} \\ & + \beta_{Lang,g}CommonLang_{ni} + \beta_{Colony,g}Colony_{ni} + \beta_{HomeBias,n,g}\mathbb{I}(n=i) + \varepsilon_{nig},\end{aligned} \tag{62}$$

and then use the predicted trade flows $\widehat{X_{nig}}^{pred}$ to provide us with predicted production for each commodity, defined as $\widehat{Y_{ig}}^{pred} \equiv \sum_n \widehat{X_{nig}}^{pred}$. However the home bias, that is, the estimated log increase in trade flows due to moving inside a country's borders, is not identified if internal flows are treated as missing.

A first solution would be to impose the home bias effect to be uniform across countries and estimate it using countries for which internal trade data are not missing. However, this would lead to overstatement of the home bias effect because of a selection bias. Countries with reported production data are more likely to be among the largest producers, and thus mechanically are more likely to consume more of their own domestic output. This induces an upward bias in the border effect coefficient, and results in predicted internal trade flows that are often implausibly large.

The solution that we propose involves two steps. First we estimate equation (62) with available trade flows. An important property to note is that the sum of fitted external flows for a country equals the sum of its observed exports or imports for that country, a property specific to PPML, with the inclusion of exporter and importer fixed effects (Fally 2015). The same holds for fitted internal flows, which equal observed internal flows in each country where internal flows are not missing, as long as country-commodity specific border effects are included in the regression. Therefore, with missing internal flows, we can use equation (62) to predict these flows up to the home bias coefficient $\beta_{HomeBias,n,g}$ for that country. We denote such fitted flows by $\widehat{X_{nng}}(\beta_{HomeBias,n,g})$.

In a second step, to estimate the home bias coefficient when internal flows are missing, we employ GTAP data at a more disaggregated level (which features almost no missing internal flows), and assume that the home bias coefficient is uniform within the country and GTAP sector G in which the commodity $g \in G$ belongs: $\beta_{HomeBias,n,g} = \beta_{HomeBias,n,G}$. We then calibrate the home bias such that predicted internal flows are equal to observed internal flows for the GTAP sector in that country. Using adding-up properties of PPML, this is equivalent to calibrating the home bias coefficient as:

$$\hat{\beta}_{HomeBias,n,G} = \log\left(\frac{\sum_{g\in G}\widehat{X_{nng}}(0)}{X_{nnG}}\right) + \log\left(\frac{\sum_{k\neq n} X_{knG}}{\sum_{g\in G}\sum_{k\neq n} X_{kng}}\right)$$

where the numerator of the first term uses fitted flows constructed without the home bias coefficient ($\beta_{HomeBias,n,g} = 0$), and the denominator is observed internal trade for the aggregate GTAP sector. As a GTAP sector may also contain other goods not covered in our analysis, we adjust our estimation for the share of such goods in the aggregate GTAP sector trade using the second term.

G - Additional Figures and Tables

Figure 15: Crop suitability for cotton (green = high potential yield)

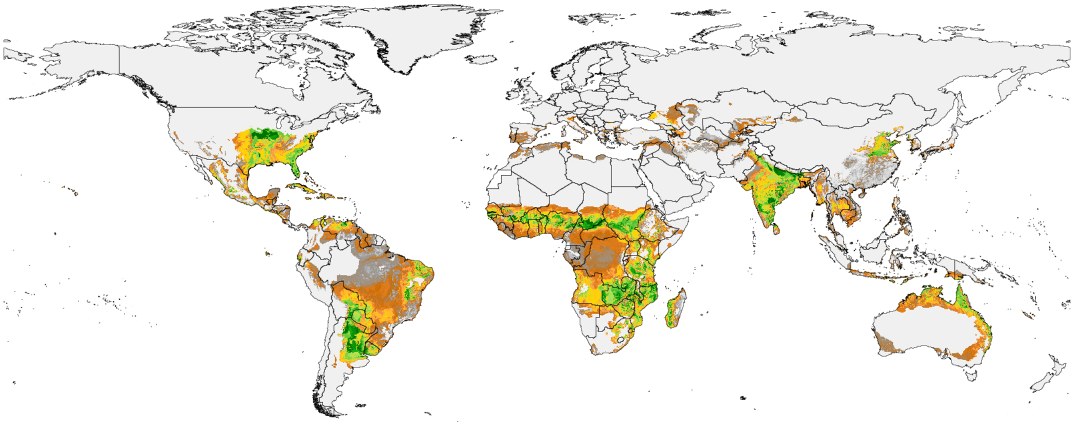
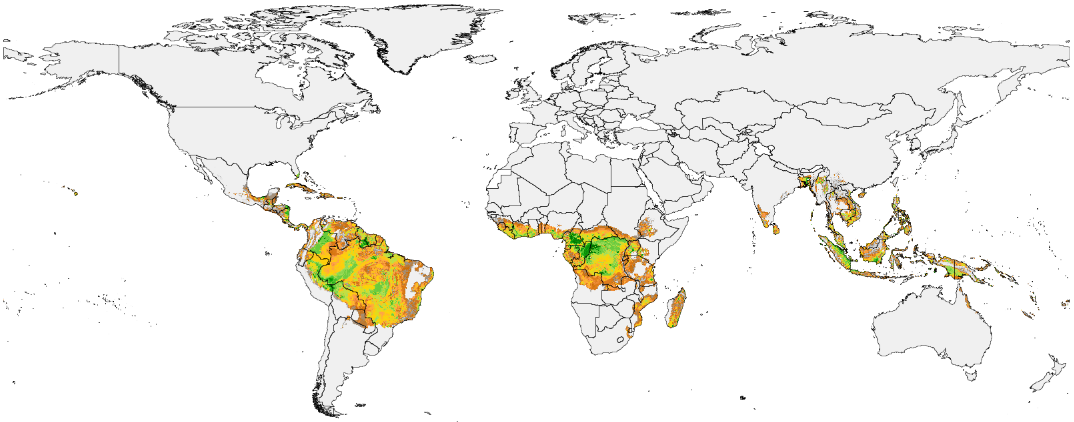


Figure 16: Crop suitability for coffee



Source: Global Agro-Ecological Zones (GAEZ) data, FAO. Model output is from GAEZ data at baseline years, an average of crop suitability from 1961-1990. Water supply is from rainfall, scarce data exists for irrigated crop suitability in GAEZ database. Model output is based on high inputs and advanced crop management, but the total amount of land which is suitable is not particularly sensitive to this assumption.

Figure 17: Harvested area of cotton (green = higher concentration)

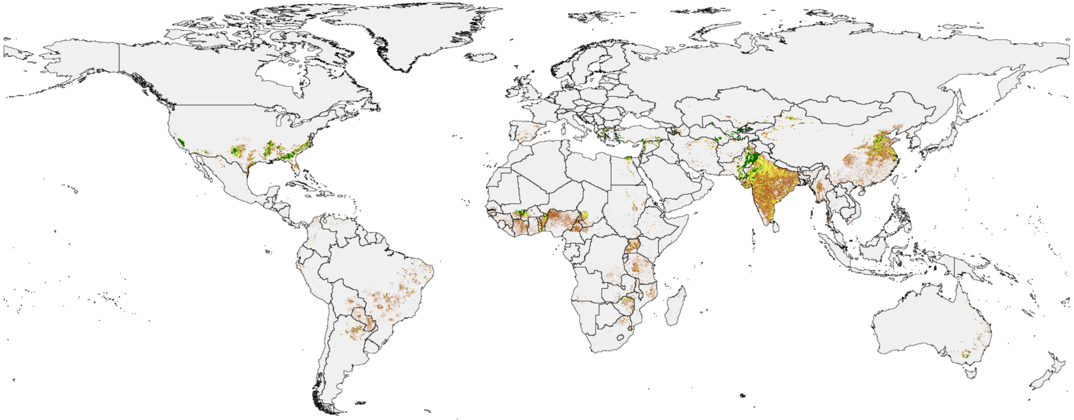
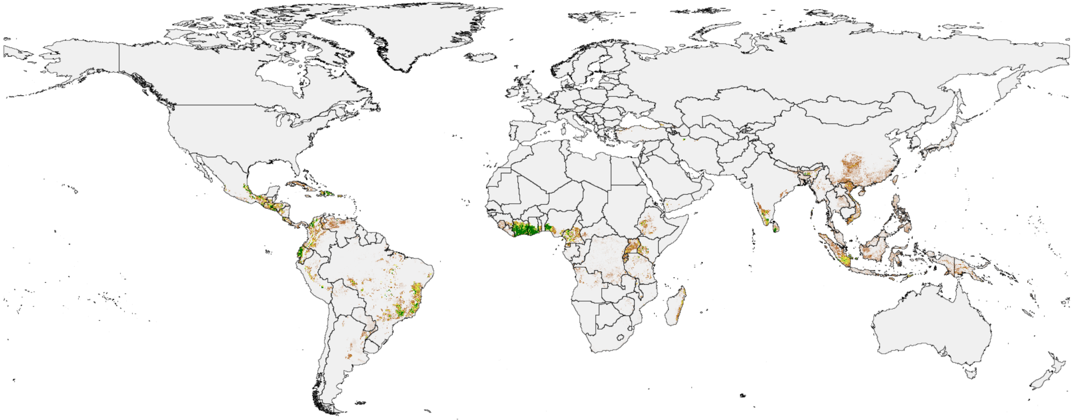


Figure 18: Harvested area of coffee



Source: Global Agro-Ecological Zones (GAEZ) data, FAO. Model output is crop harvested area for both irrigated and rain-fed land.

Figure 19: Crop suitability for maize; source: GAEZ

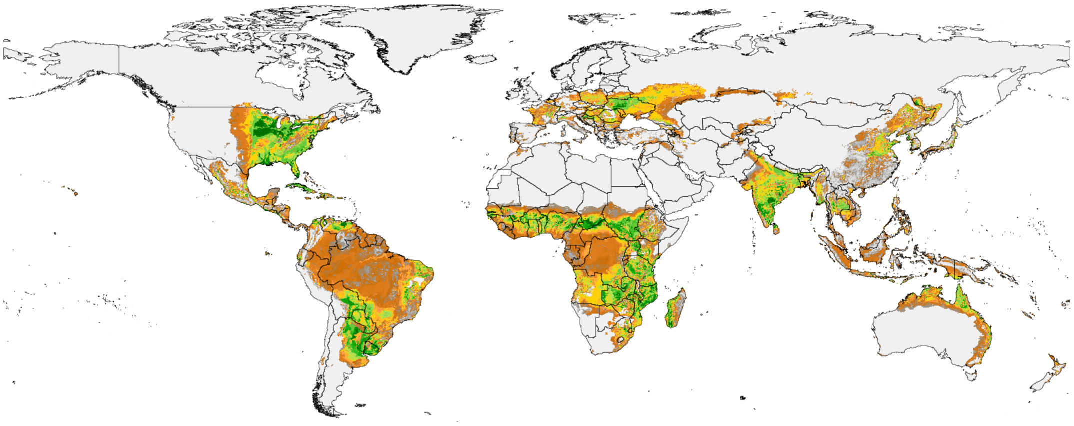
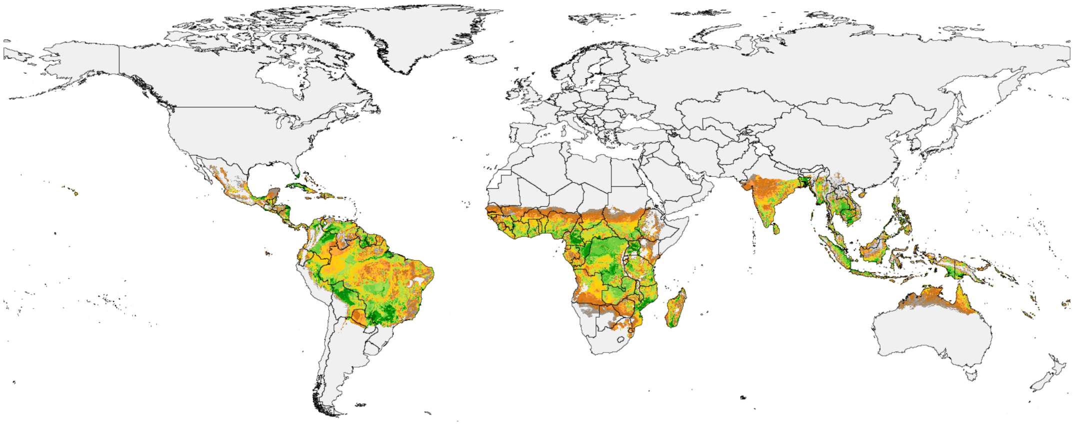


Figure 20: Crop suitability for dryland rice; source: GAEZ



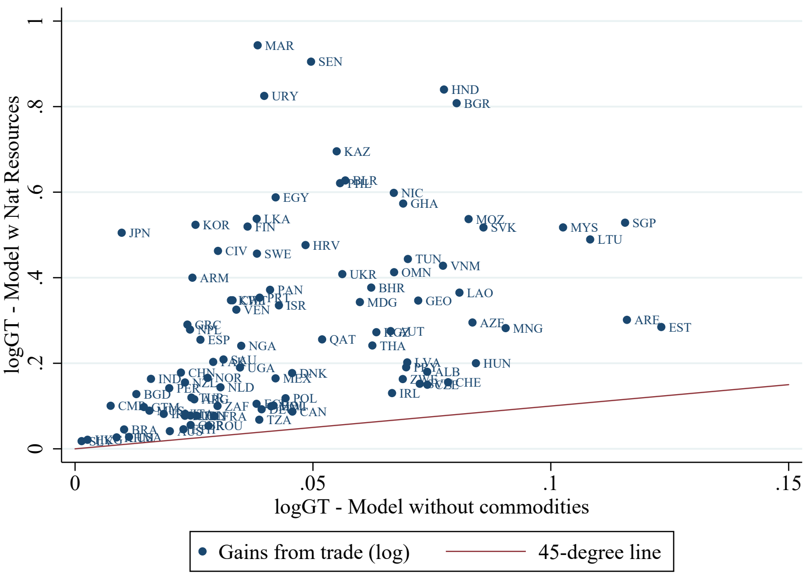


Figure 21: Gains from trade relative to gains from trade in manufacturing only

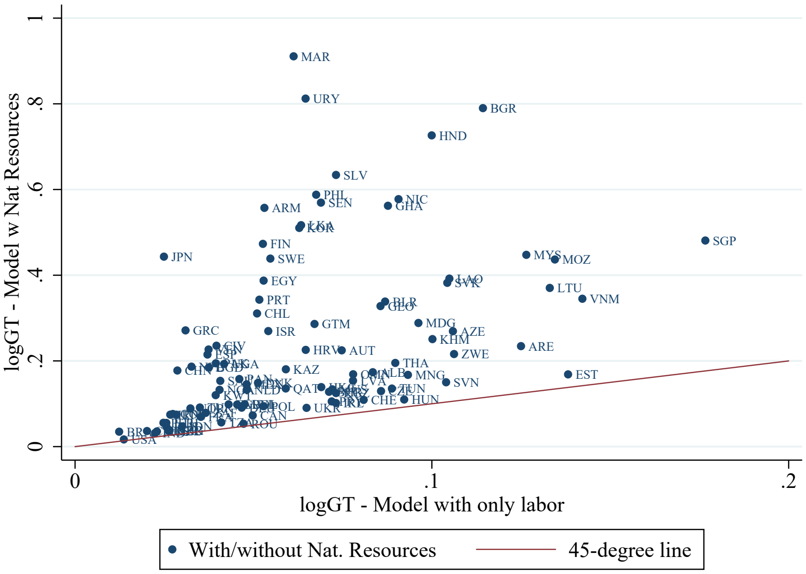


Figure 22: G.T. relative to model with only labor – ignoring zero production cells instead of using gravity equations to fill in zeros

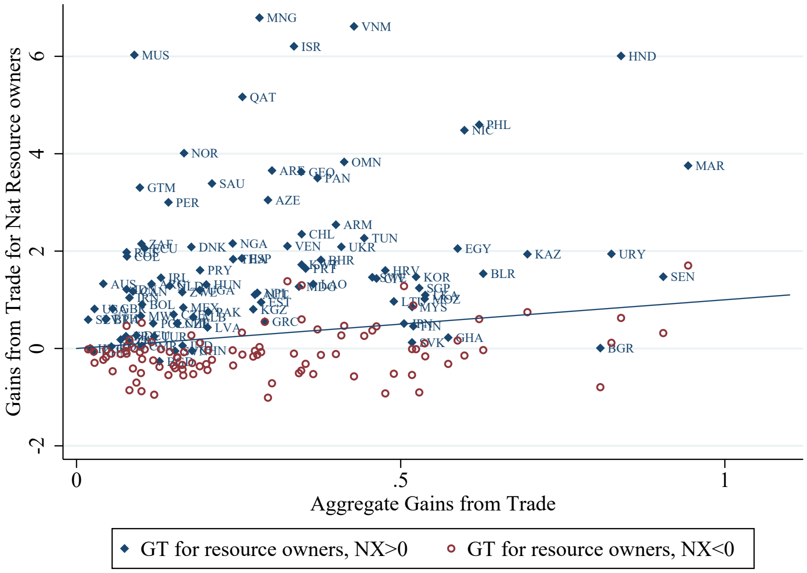


Figure 23: Resources owners' gains from trade and share of income from natural resources

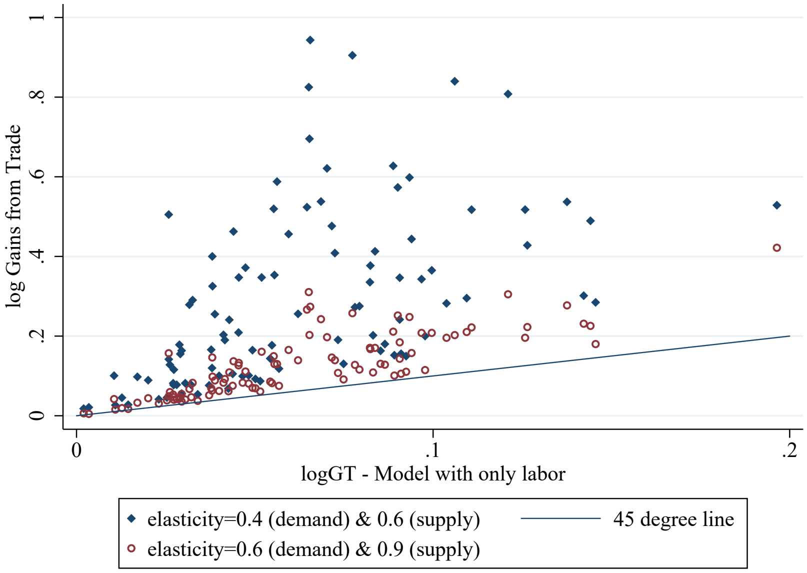


Figure 24: Gains from trade with a moderately higher elasticity of substitution

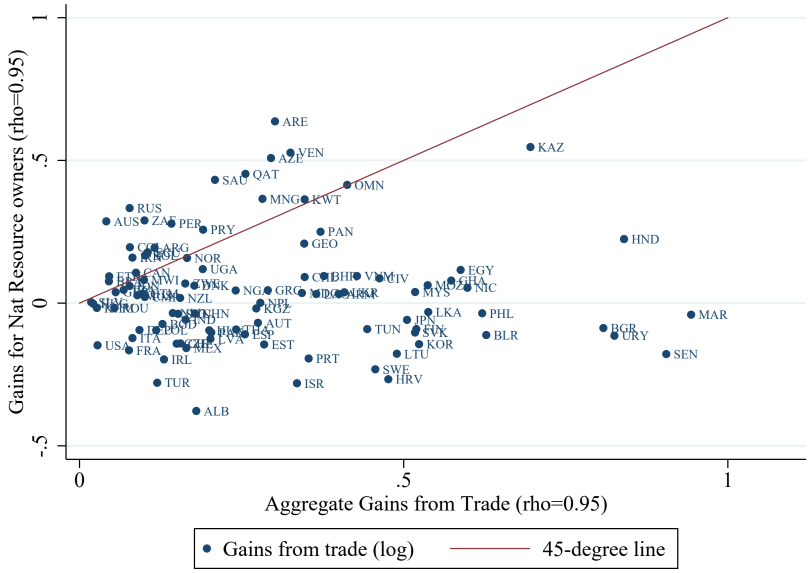


Figure 25: Resource owners gains from trade with a lower elasticity of substitution

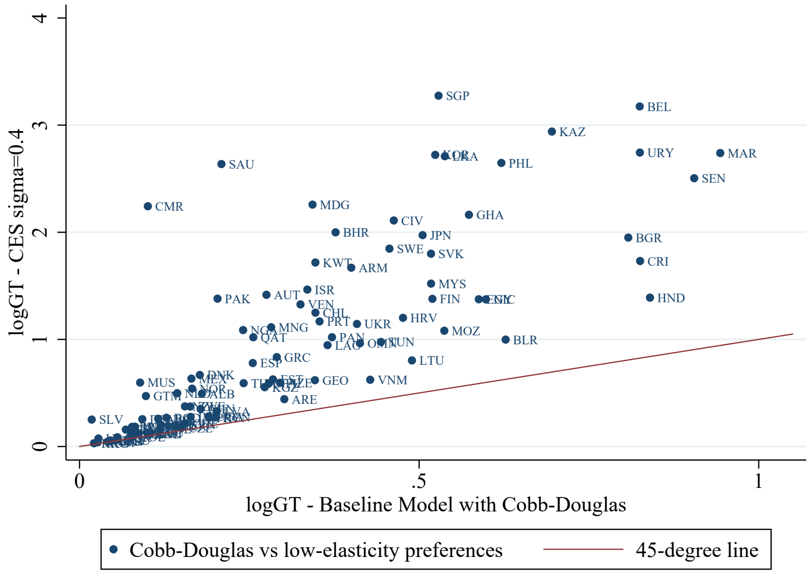


Figure 26: Role of the elasticity of substitution in preferences across final goods

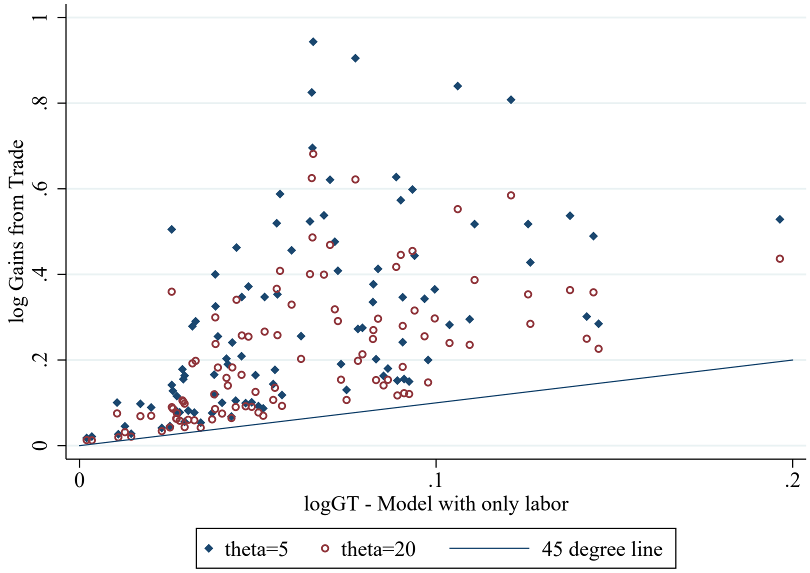


Figure 27: Gains from Trade with Higher Trade Elasticity for Commodities: $\theta_g = 20$ vs. 5

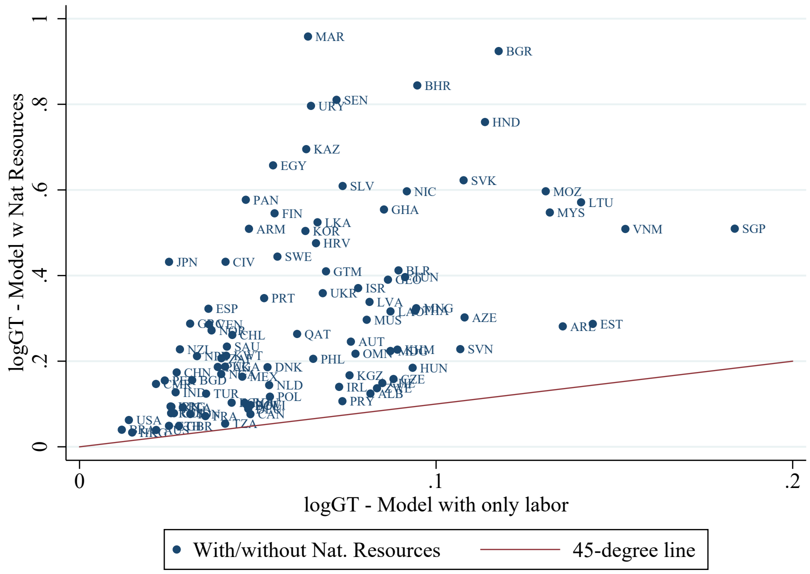
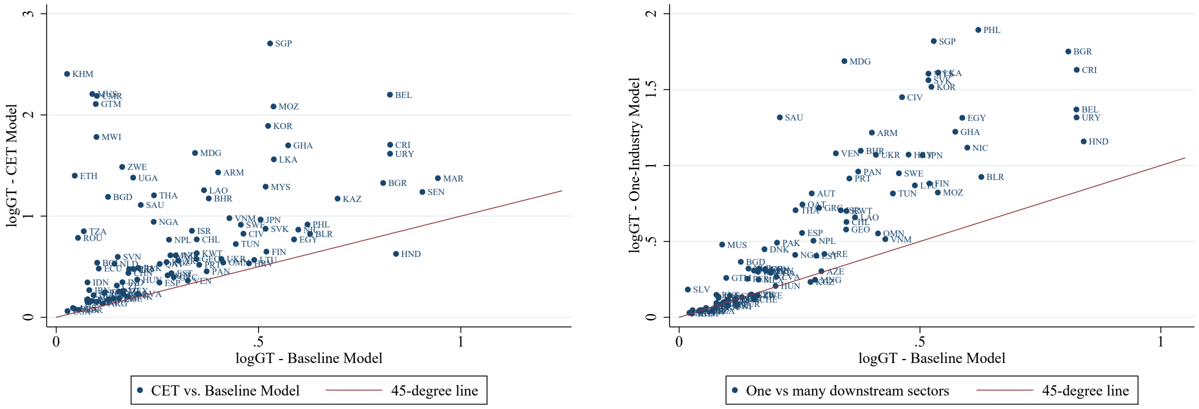


Figure 28: G.T. relative to model with only labor – more conservative classification

Figure 29: Gains from trade with alternative specifications



(a) Land allocation with CET production function

(b) Only one Downstream Sector

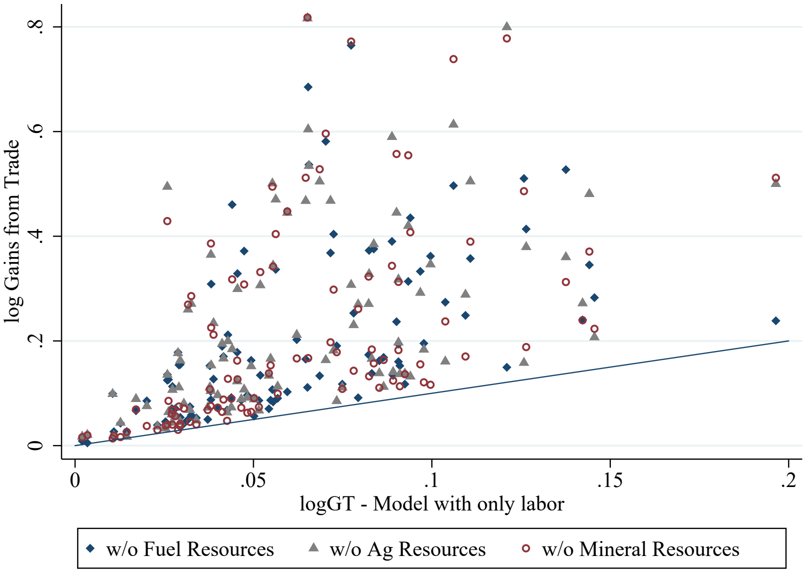


Figure 30: Gains from Trade – sensitivity to removing certain types of commodities

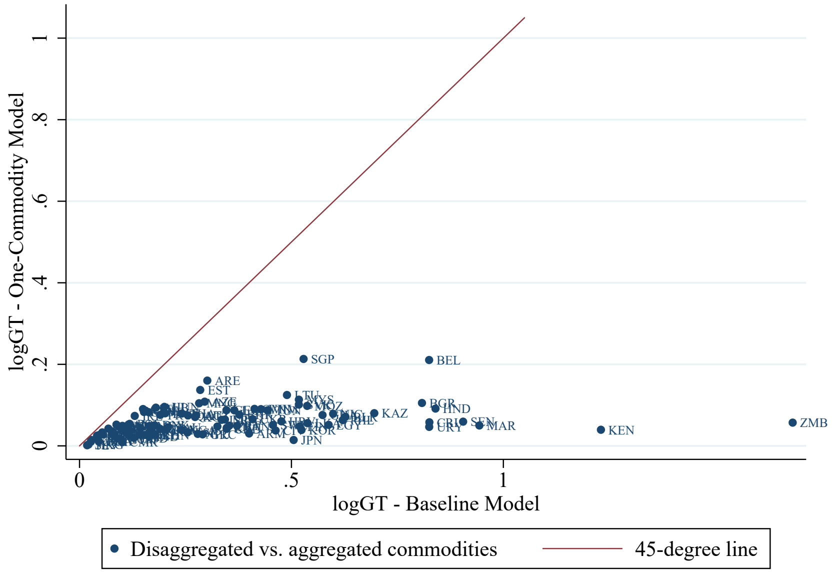


Figure 31: Gains from trade estimated after aggregating commodity production and trade

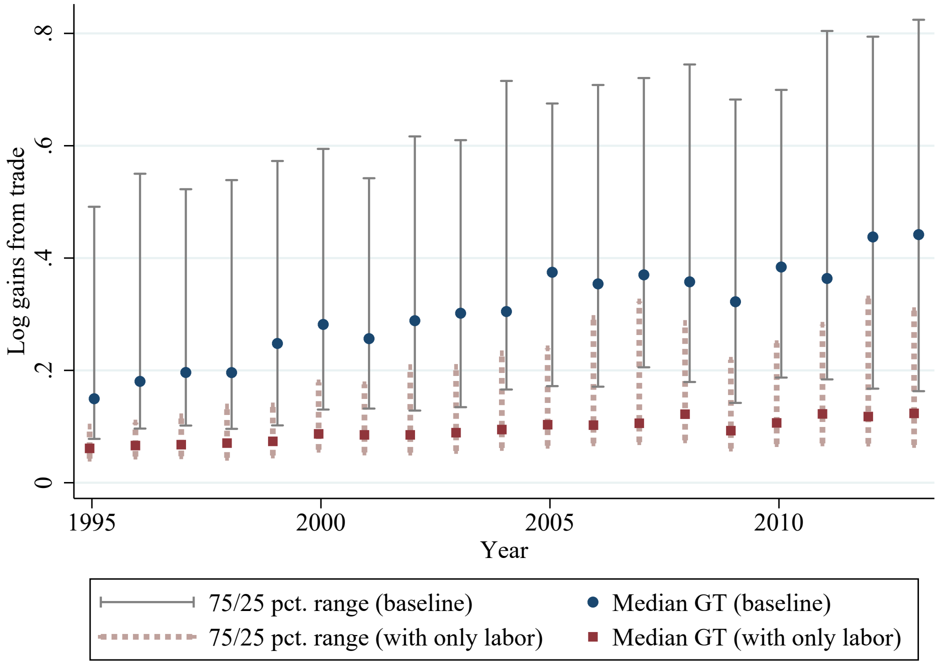


Figure 32: Gains from trade across years – aggregating downstream industries

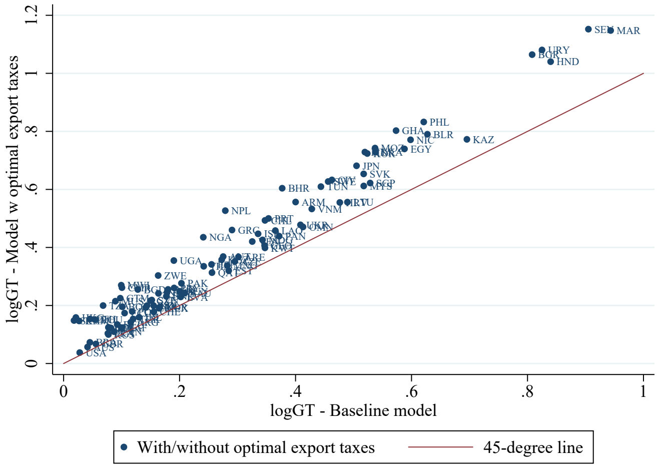
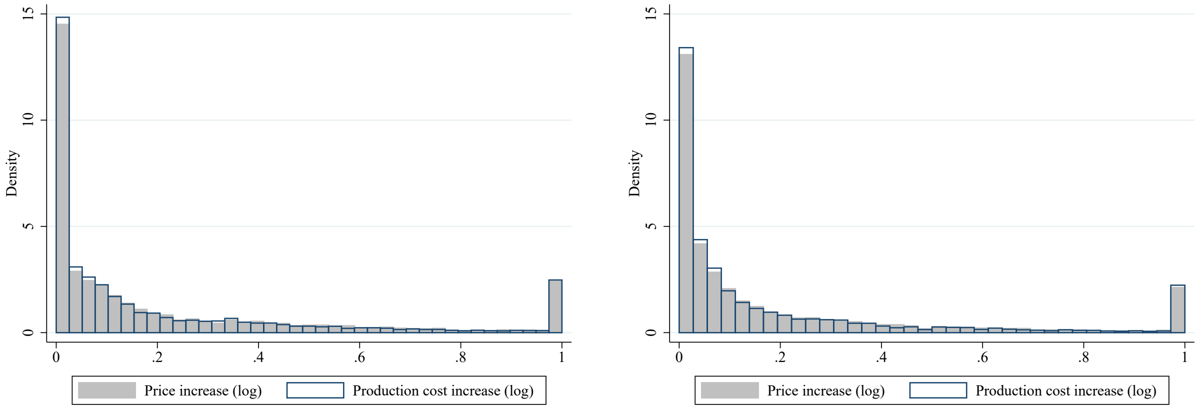


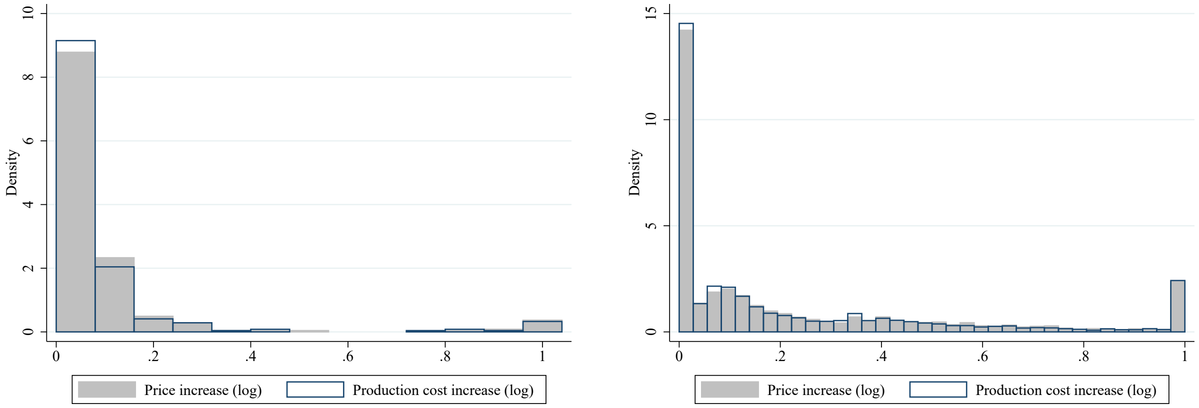
Figure 33: Gains from trade – optimal export tax vs. competitive baseline

Figure 34: Shutting down trade with the top exporter – Effect on prices and production costs



(a) Across all commodities

(b) Agricultural commodities



(c) Fuel commodities

(d) Minerals

Table 10: Share of Products in World Trade

Year	Minerals	Agriculture	Fuels	Primary Commodities
1995	0.065	0.037	0.048	0.111
1996	0.059	0.037	0.059	0.120
1997	0.059	0.036	0.058	0.116
1998	0.058	0.034	0.042	0.097
1999	0.051	0.031	0.052	0.102
2000	0.055	0.026	0.071	0.116
2001	0.052	0.027	0.067	0.111
2002	0.051	0.027	0.066	0.111
2003	0.053	0.028	0.069	0.114
2004	0.061	0.025	0.080	0.124
2005	0.065	0.023	0.095	0.139
2006	0.073	0.022	0.101	0.145
2007	0.081	0.024	0.097	0.147
2008	0.077	0.025	0.127	0.177
2009	0.064	0.028	0.103	0.154
2010	0.071	0.027	0.112	0.167
2011	0.074	0.028	0.126	0.183
2012	0.067	0.028	0.129	0.182
2013	0.064	0.028	0.122	0.175
2014	0.064	0.029	0.105	0.157

Notes: BACI-COMTRADE international trade data.

Table 11: Products with the highest concentration of imports to a single destination

Product	Largest Importer	Import Share	Top 3 Share	Product	Largest Importer	Import Share	Top 3 Share
Cobalt	China	0.628	0.879	Mate	Uruguay	0.448	0.76
Cassava	China	0.597	0.799	Flax	China	0.435	0.639
Oats	USA	0.565	0.687	Soy beans	China	0.434	0.562
Chromium	China	0.563	0.705	Rare Earths	Japan	0.425	0.68
Almonds	India	0.545	0.656	Buckwheat	Japan	0.422	0.573
Germanium	Belarus	0.515	0.871	Uranium	USA	0.422	0.811
Iron and Steel	China	0.489	0.682	Tin	Malaysia	0.393	0.791
Fava beans	Egypt	0.487	0.612	Papayas	USA	0.376	0.529
Linseed	Belgium	0.483	0.746	Asparagus	USA	0.371	0.558
Iridium	USA	0.468	0.803	Vanilla	USA	0.36	0.657
Legumes nec	India	0.463	0.625	Berries	USA	0.359	0.665
Avocados	USA	0.455	0.655	Lead	China	0.343	0.615

Notes: Share of imports from largest importer and top-3 importers for each HS6 product (or aggregated product). Source: BACI data in 2007.

Table 12: Products with the highest concentration of production from one country

Product	Largest Producer	Prod. Share	HHI	Product	Largest Producer	Prod. Share	HHI
Rare Earths	China	0.984	0.969	Chickpeas	India	0.648	0.435
Germanium	China	0.943	0.892	Hazelnuts	Turkey	0.642	0.442
Asparagus	China	0.937	0.879	Peaches	China	0.641	0.421
Spinach	China	0.929	0.863	Jute	India	0.612	0.445
Antimony	China	0.896	0.804	Magnesium	China	0.608	0.394
Garlic	China	0.889	0.790	Apples	China	0.599	0.366
Chestnuts	China	0.882	0.780	Cauliflowers	China	0.590	0.393
Beryl	USA	0.874	0.777	Fava beans	China	0.589	0.366
Sweet potatoes	China	0.856	0.734	Mercury	China	0.588	0.410
Magnesium	China	0.843	0.716	Peas	China	0.585	0.363
Cucumbers	China	0.825	0.682	Wollastonite	China	0.583	0.395
Platinum	S. African C.U.	0.809	0.670	Carrots	China	0.577	0.339
Mushrooms	China	0.809	0.657	Iodine	Chile	0.573	0.449
Melons	China	0.767	0.590	Barytes	China	0.563	0.343
Pears	China	0.760	0.581	Tobacco	China	0.559	0.330
Canary seed	Canada	0.748	0.584	Lithium	Australia	0.555	0.346
Eggplants	China	0.738	0.571	Fluorspar	China	0.555	0.346
Niobium	Brazil	0.732	0.553	Mandarins	China	0.553	0.319
Cloves	Indonesia	0.730	0.552	Seeds	India	0.544	0.318
Graphite	China	0.707	0.529	Arsenic	China	0.541	0.365
Tungsten	China	0.703	0.510	Mate	Brazil	0.537	0.427
Flax	China	0.698	0.507	Sillimanite	S. African C.U.	0.536	0.371
Peppers	China	0.679	0.467	Palladium	Russia	0.536	0.408
Celery	China	0.674	0.463	Almonds	USA	0.531	0.300
Lettuce	China	0.672	0.470	Citruses	China	0.526	0.343
Spices	India	0.670	0.466	Roots	Nigeria	0.519	0.294
Plums	China	0.664	0.446	Peanuts	China	0.518	0.308
Brussel sprouts	China	0.655	0.436	Gallium	China	0.517	0.304

Notes: Share of production (in quantities) from the largest producer for each commodity in the year 2007. Second column is the Herfindahl-Hirschman index, where a number above 0.25 indicates a high concentration of production. Source: Authors' calculations, using country level FAO and BGS production data.

G - Sources for Elasticity Estimates

References

Adams, F. G., and J. R. Behrman. 1976. *Econometric models of world agricultural commodity markets: cocoa, coffee, tea, wool, cotton, sugar, wheat, rice.* Ballinger Publishing Company.

Akiyama, T., and P. N. Varangis. 1990. “The impact of the International Coffee Agreement on producing countries.” *The World Bank Economic Review* 4 (2): 157–173.

Askari, H., and J. T. Cummings. 1977. “Estimating agricultural supply response with the Nerlove model: A survey.” *International Economic Review:* 257–292.

Auffhammer, M., and E. Rubin. 2018. “Natural gas elasticities and optimal cost recovery under heterogeneity: Evidence from 300 million natural gas bills.” *NBER WP No. 24295.*

Banks, F. E. 1972. “An econometric model of the world tin economy: A comment.” *Econometrica: Journal of the Econometric Society:* 749–752.

Banks, F. E. 1974. *The world copper market: an economic analysis.* Ballinger Pub. Co.

Barret, C. 1992. “US natural gas market: a disequilibrium approach.” In *Coping with the energy future: markets and regulations. Volume 2.*

Behrman, J. 1975. *Mini models for eleven international commodity markets.* Report prepared for UNCTAD, University of Pennsylvania.

Behrman, J. R. 1965. “Cocoa: A Study of Demand Elasticities in the Five Leading Consuming Countries, 1950-1961.” *Journal of Farm Economics* 47 (2): 410–417.

Blomberg, J., and S. Hellmer. 2000. “Short-run demand and supply elasticities in the West European market for secondary aluminium.” *Resources Policy* 26 (1): 39–50.

Borrell, B., and K. Hanslow. 2004. *Banana supply elasticities.* Centre for International Economics, Canberra.

Burke, P. J., and H. Liao. 2015. “Is the price elasticity of demand for coal in China increasing?” *China Economic Review* 36:309–322.

Burrows, J. C. 1974. “Prepared Statement to the U.S. Congress.” *Outlook for prices and supplies of industrial raw materials : Hearings before the Subcommittee on Economic Growth of the Joint Economic Committee, Congress of the United States, Ninety-third Congress, second session, July 22, 23, and 25, 1974.* 425–476.

Caldara, D., M. Cavallo, and M. M. Iacoviello. 2016. “Oil price elasticities and oil price fluctuations.”

Chhabra, J., E. Grilli, and P. Pollak. 1979. “The World Tin Economy: An Econometric Analysis.” *Metroeconomica* 31 (1).

Choe, B.-J. 1990. “The metals price boom of 1987-89: the role of supply disruptions and stock changes.” *The World Bank Policy Research Working Paper Series No. 542.*

Connelly, P., and R. Perlman. 1975. “The politics of scarcity: resource conflicts in international relations.”

Coyle, D., J. DeBacker, and R. Prisinzano. 2012. “Estimating the supply and demand of gasoline using tax data.” *Energy Economics* 34 (1): 195–200.

Dahl, C., and T. E. Duggan. 1996. “U.S. energy product supply elasticities: A survey and application to the U.S. oil market.” *Resource and Energy Economics* 18 (3): 243–263.

Dahl, C., and T. Sterner. 1991. “Analysing gasoline demand elasticities: a survey.” *Energy economics* 13 (3): 203–210.

Damuth, R. 2011. “Estimating the Price Elasticity of Ferrous Scrap Supply.” *Nathan Associates Inc.*

Espey, M. 1998. “Gasoline demand revisited: an international meta-analysis of elasticities.” *Energy Economics* 20 (3).

Evans, M., and A. C. Lewis. 2002. “Is there a common metals demand curve?” *Resources Policy* 28 (3): 95–104.

Fisher, F. M., P. H. Cootner, and M. N. Baily. 1972. “An econometric model of the world copper industry.” *The Bell Journal of Economics and Management Science* 3 (2): 568–609.

Foley, P., and J. Clark. 1981. “US copper supply: An economic/engineering analysis of cost-supply relationships.” *Resources Policy* 7 (3): 171–187.

Food and Agricultural Policy Research Institute. 2017. *Elasticities Database.* Iowa State University.

Gupta, P., and S. Gupta. 1983. “World demand for cobalt: An econometric study.” *Resources Policy* 9 (4): 261–274.

Haile, M. G., J. Brockhaus, and M. Kalkuhl. 2016. “Short-term acreage forecasting and supply elasticities for staple food commodities in major producer countries.” *Agricultural and Food Economics* 4 (1).

Hashimoto, H., and T. Sihsobhon. 1981. “A world iron and steel economy model: the WISE model.” *World Bank commodity models* 1:1–46.

Hogan, W. W. 1989. *World oil price projections: a sensitivity analysis.* Energy / Environmental Policy Center, John F. Kennedy School of Government, Harvard University.

Hojman, D. E. 1981. “An econometric model of the international bauxite-aluminium economy.” *Resources Policy* 7 (2).

Hughes, J., C. Knittel, and D. Sperling. 2008. “Evidence of a Shift in the Short-Run Price Elasticity of Gasoline Demand.” *The Energy Journal* 29 (1).

Jenkins, R. O. 2011. “The “China effect” on commodity prices and Latin American export earnings.” *Cepal Review.*

Kilian, L., and D. P. Murphy. 2014. “The role of inventories and speculative trading in the global market for crude oil.” *Journal of Applied Econometrics* 29 (3): 454–478.

Krichene, M. N. 2005. “A simultaneous equation model for world crude oil and natural gas markets,” nos. 5-32.

Krichene, N. 2002. “World crude oil and natural gas: a demand and supply model.” *Energy economics* 24 (6): 557–576.

Kumar, P., A. Kumar, S. Parappurathu, and S. Raju. 2011. “Estimation of demand elasticity for food commodities in India.” *Agricultural Economics Research Review* 24 (1).

Kumar, P., P. Shinoj, S. S. Raju, A. Kumar, K. M. Rich, and S. Msangi. 2010. “Factor Demand, Output Supply Elasticities and Supply Projections for Major Crops of India.” *Agricultural Economics Research Review* 23 (1).

Labys, W. C., S. Paik, and A. M. Liebenthal. 1979. “An econometric simulation model of the US market for steam coal.” *Energy Economics* 1 (1): 19–26.

Luchansky, M. S., and J. Monks. 2009. “Supply and demand elasticities in the US ethanol fuel market.” *Energy Economics* 31 (3): 403–410.

MacKinnon, J. G., and N. D. Olewiler. 1980. “Disequilibrium estimation of the demand for copper.” *The Bell Journal of Economics:* 197–211.

Muhammad, A., J. L. Seale, B. Meade, and A. Regmi. 2011. “International evidence on food consumption patterns: an update using 2005 international comparison program data.” *US Department of Agriculture Economic Research Service Technical Bulletin No. 1929.*

Okunade, A. A. 1992. “Functional forms and habit effects in the US demand for coffee.” *Applied Economics* 24 (11).

Pobukadee, J. 1980. “An Econometric Analysis of the World Copper Market.” *Wharton Econometric Forecasting Associates.*

Priovolos, T. 1987. “Econometric Model of the Iron ore Industry.” *World Bank Staff Commodity WP No. 19.*

Radetzki, M. 1984. “Strategic metal markets: Prospects for producer cartels.” *Resources Policy* 10 (4): 227–240.

Rafati, R. 1984a. “Cobalt.” Chap. 2 in *The Economics of Deep-sea Mining,* edited by J. B. Donges, 62–112.

———. 1984b. “Nickel.” Chap. 5 in *The Economics of Deep-sea Mining,* edited by J. B. Donges, 253–335.

Russo, C., R. D. Green, and R. E. Howitt. 2008. “Estimation of Supply and Demand Elasticities of California Commodities.” *Department of Agricultural & Resource Economics, UC Davis.*

Al-Sahlawi, M. A. 1989. “The Demand for Natural Gas: A Survey of Price and Income Elasticities.” *The Energy Journal* 10 (1): 77–90.

Schneider, E. A., and W. C. Sailor. 2008. “Long-term uranium supply estimates.” *Nuclear Technology* 162 (3): 379–387.

Sibley, S. 1980. “Cobalt: A strategic and critical resource for industrialized nations, supplied by developing nations.” In *Natural Resources Forum,* 4:403–413.

Sigman, H. 1995. “A comparison of public policies for lead recycling.” *The RAND journal of Economics:* 452–478.

———. 2004. “Targeting Lead in Solid Waste.” *Addressing the Economics of Waste:* 161–180.

Slade, M. 1992. “Environmental costs of natural resource commodities: magnitude and incidence.” *World Bank WP991.*

Stuermer, M. 2017. “Industrialization and the demand for mineral commodities.” *Journal of International Money and Finance* 76:16–27.

Tan, C. S. 1977. “The world tungsten economy: An econometric model.” *Resources Policy* 3 (4): 281–291.

Varon, B., and K. Takeuchi. 1974. “Developing countries and non-fuel minerals.” *Foreign Affairs* 52 (3): 497–510.

Wagenhals, G. 1983. “Copper.” Chap. 2 in *The Economics of Deep-sea Mining,* edited by J. B. Donges, 113–203.

Williams, G. W., and R. L. Thompson. 1984. “Brazilian Soybean Policy: The International Effects of Intervention.” *American Journal of Agricultural Economics* 66 (4): 488–498.