Online Appendix

Product Variety, the Cost of Living and Welfare Across Countries

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A.1 Proof of Proposition 1

The final equality in (10) uses $M_s^i \propto L_s^i / F_s^i$. To prove this condition, we complete the description of the model in part (i) below, and then we prove Proposition 1 in part (ii).

Part i):

With labor income of $w^i L^i$ in country *i* and the CES utility function with elasticity η between sectors, leading to the country price index in (3), then expenditure on sector *s* is

$$X_s^i = a_s w^i L^i (P_s^i / P^i)^{1-\eta}. \tag{A1}$$

We have assumed trade balance, so that total expenditure is $\sum_{s=1}^{S} X_s^i = w^i L^i$. CES demand within each sector implies the consumer prices $p_s^{ij}(\varphi) = [\sigma_s / (\sigma_s - 1)]\, (\tau_s^{ij} w^i / \varphi)$, so that country *j* demand for the output from a country *i* firm with productivity φ is:

$$y_s^{ij}(\varphi) = \frac{X_s^j}{P^{j(1-\sigma_s)}} \left[\frac{w^i \tau_s^{ij} \sigma_s}{\varphi(\sigma_s - 1)} \right]^{-\sigma_s}. \tag{A2}$$

Multiplying by price minus variable costs, $p_s^{ij}(\varphi) - (w^i \tau_s^{ij} / \varphi) = [1/(\sigma_s - 1)]\, (w^i \tau_s^{ij} / \varphi)$, profits are

$$\pi_s^{ij}(\varphi) = \underbrace{\left[\frac{X_s^j}{\sigma_s^{\sigma_s}} \left(\frac{w^i \tau_s^{ij}}{P_s^j (\sigma_s - 1)} \right)^{1-\sigma_s} \right]}_{B_s^{ij}} \varphi^{\sigma_s - 1} - w^i f_s^{ij}.$$

It follows that the zero-cutoff-profit (ZCP) condition is:

$$\pi_s^{ij}(\varphi) = B_s^{ij}\varphi_s^{ij(\sigma-1)} - w^i f_s^{ij} = 0 \;\Rightarrow\; \varphi_s^{ij(\sigma_s-1)} = \frac{w^i f_s^{ij}}{B_s^{ij}} = \frac{w^i f_s^{ij}\sigma_s^{\sigma_s}}{X_s^{ij}}\left(\frac{w^i\tau_s^{ij}}{P_s^j(\sigma_s-1)}\right)^{\sigma_s-1}, \quad \text{(A3)}$$

which appears as condition (8) in the main text for $j = i$.

Total employment in sector s at home for domestic and export sales equals:

$$L_s^i = M_s^i F_s^i + \sum_{j=1}^{C} M_s^{ij} \int_{\varphi_s^{ij}}^{\infty}\left[\frac{\tau_s^{ij} y_s^{ij}(\varphi)}{\varphi} + f_s^{ij}\right]\frac{g_s^i(\varphi)}{[1-G_s^i(\varphi_s^{ij})]}d\varphi . \quad \text{(A4)}$$

Notice that we have multiplied the quantity delivered to home and foreign consumers by their respective iceberg costs, τ_s^{ij}, and summed across destination to obtain the total quantity produced by the firm. Multiply the entire expression by wages w^i, move the fixed costs f_s^{ij} out of the brackets to combine with F_s^i, and then multiply and divide the remaining production terms by $\sigma_s/(\sigma_s - 1)$ to obtain prices $p_s^{ij}(\varphi) = [\sigma_s/(\sigma_s - 1)]\,(\tau_s^{ij} w^i/\varphi)$. Then we obtain:

$$\begin{aligned} w^i L_s^i &= w^i\left(M_s^i F_s^i + \textstyle\sum_{j=1}^{C} M_s^{ij} f_s^{ij}\right) + \left(\frac{\sigma_s - 1}{\sigma_s}\right)\left[\sum_{j=1}^{C} M_s^{ij}\int_{\varphi_s^{ij}}^{\infty}\frac{p_s^{ij}(\varphi)y_s^{ij}(\varphi)g_s^i(\varphi)}{[1-G_s^i(\varphi_s^{ij})]}d\varphi\right] \\ &= w^i\left(M_s^i F_s^i + \textstyle\sum_{j=1}^{C} M_s^{ij} f_s^{ij}\right) + \left(\frac{\sigma_s - 1}{\sigma_s}\right) w^i L_s^i, \end{aligned}$$

where the second line follow because the bracketed term on the first line is total revenue earned by firms in sector s. With zero expected profits, total revenue in sector s equals the payments to labor $w^i L_s^i$, so then $L_s^i = \sigma_s(M_s^i F_s^i + \sum_{j=1}^{C} M_s^{ij} f_s^{ij})$ is obtained. It follows that the sector s employment condition (A4) is simplified as:

$$\left(\frac{\sigma_s - 1}{\sigma_s}\right) L_s^i = \sum_{j=1}^{C} M_s^{ij}\int_{\varphi_s^{ij}}^{\infty}\left[\frac{\tau_s^{ij} y_s^{ij}(\varphi)}{\varphi}\right]\frac{g_s^i(\varphi)}{[1-G_s^i(\varphi_s^{ij})]}d\varphi . \quad \text{(A5)}$$

Note that CES demand with prices $p_s^{ij}(\varphi) = [\sigma_s/(\sigma_s - 1)]\,(\tau_s^{ij} w^i/\varphi)$, implies that output is

$y_s^{ij}(\varphi) = (\varphi/\varphi_s^{ij})^{\sigma_s}\, y_s^{ij}(\varphi_s^{ij})$, where $y_s^{ij}(\varphi_s^{ij})$ is the output of the ZCP firm. Using the Pareto distribution for productivity, the integral in (A5) is then:

$$\int_{\varphi_s^{ij}}^{\infty} \left[\frac{\tau_s^{ij} y_s^{ij}(\varphi)}{\varphi}\right] \frac{g_s^i(\varphi)}{[1-G_s^i(\varphi_s^{ij})]} d\varphi = \int_{\varphi_s^{ij}}^{\infty} \frac{\tau_s^{ij} y_s^{ij}(\varphi_s^{ij})}{\varphi} \left(\frac{\varphi}{\varphi_s^{ij}}\right)^{\sigma_s} \frac{g_s^i(\varphi)}{[1-G_s^i(\varphi_s^{ij})]} d\varphi$$

$$= \frac{\tau_s^{ij} y_s^{ij}(\varphi_s^{ij})}{\varphi_s^{ij}} \int_{\phi_d}^{\infty} \left(\frac{\varphi}{\varphi_s^{ij}}\right)^{\sigma_s - 1} \frac{\theta(\varphi)^{-\theta-1}}{(\varphi_s^{ij})^{-\theta}} d\varphi$$

$$= \frac{\tau_s^{ij} y_s^{ij}(\varphi_s^{ij})}{\varphi_s^{ij}} \frac{\theta}{(\sigma_s - \theta - 1)} \left(\frac{\varphi}{\varphi_s^{ij}}\right)^{\sigma_s - \theta - 1} \Bigg|_{\varphi_s^{ij}}^{\infty}$$

$$= f_s^{ij} \frac{\theta(\sigma_s - 1)}{(\theta - \sigma_s + 1)},$$

where the last line uses $\tau_s^{ij} y_s^{ij}(\varphi_s^{ij})/\varphi_s^{ij} = (\sigma_s - 1) f_s^{ij}$, as follows from (A2) and (A3). Substituting the last line above back into (A5) we arrive at:

$$L_s^i = \sum_{j=1}^{C} M_s^{ij} f_s^{ij} \frac{\theta\sigma_s}{(\theta - \sigma_s + 1)}.$$

Using $L_s^i = \sigma_s (M_s^i F_s^i + \sum_{j=1}^{C} M_s^{ij} f_s^{ij})$ we obtain $M_s^i = L_s^i(\sigma_s - 1)/F_s^i\theta\sigma_s$ so that $M_s^i \propto L_s^i / F_s^i$.

Part ii):

Now completing the proof of Proposition 1, rewriting (7) very slightly, we have:

$$\frac{P_s^i}{P_s^j} = \left(\frac{w^i \tau_s^{ii}}{w^j \tau_s^{jj}}\right) \left(\frac{M_s^{ii}/\lambda_s^{ii}}{M_s^{jj}/\lambda_s^{jj}}\right)^{\frac{1}{(1-\sigma_s)}} \left(\frac{\varphi_s^{ii}}{\varphi_s^{jj}}\right)^{-1}.$$

The ratio of threshold productivity appearing on the right is solved using (10) as,

$$\frac{\varphi_s^{ii}}{\varphi_s^{jj}} = \left(\frac{A_s^i}{A_s^j}\right) \left(\frac{\lambda_s^{ii}}{\lambda_s^{jj}}\right)^{-\frac{1}{\theta}} \left(\frac{X_s^i / w^i L_s^i}{X_s^j / w^j L_s^i}\right)^{-\frac{1}{\theta}}.$$

where $f_s^i / F_s^i = f_s^j / F_s^j$ from Assumption 1. Substituting this into (7), we obtain

$$\frac{P_s^i}{P_s^j} = \frac{w^i / [A_s^i (\mu_s^i)^{\frac{1}{\theta}}]}{w^i / [A_s^i (\mu_s^i)^{\frac{1}{\theta}}]} \left(\frac{\lambda_s^{ii}}{\lambda_s^{jj}} \right)^{\frac{1}{\theta}} \left(\frac{\tau_s^{ii}}{\tau_s^{jj}} \right) \left(\frac{M_s^{ii} / \lambda_s^{ii}}{M_s^{jj} / \lambda_s^{jj}} \right)^{\frac{1}{(1-\sigma_s)}} \left(\frac{X_s^i / w^i L^i}{X_s^j / w^j L^i} \right)^{\frac{1}{\theta}}, \qquad \text{(A6)}$$

where $\mu_s^i \equiv L_s^i / L^i$ denote the share of the labor force in each sector. Notice that the final term above is the ratio of $x_s^i \equiv X_s^i / w^i L^i$ in countries *i* and *j*, which are the sectoral expenditure shares.

Consider taking the geometric mean of (A6) as in (11), using the Sato-Vartia weights. Then:

$$\frac{P^i}{P^j} = \prod_{s=1}^{S} \left(\frac{P_s^i}{P_s^j} \right)^{\omega_s^{ij}}$$

$$= \prod_{s=1}^{S} \left\{ \frac{w^i / [A_s^i (\mu_s^i)^{\frac{1}{\theta}}]}{w^i / [A_s^i (\mu_s^i)^{\frac{1}{\theta}}]} \right\}^{\omega_s^{ij}} \left(\frac{\lambda_s^{ii}}{\lambda_s^{jj}} \right)^{\frac{\omega_s^{ij}}{\theta}} \left(\frac{\tau_s^{ii}}{\tau_s^{jj}} \right)^{\omega_s^{ij}} \left(\frac{M_s^{ii} / \lambda_s^{ii}}{M_s^{jj} / \lambda_s^{jj}} \right)^{\frac{-\omega_s^{ij}}{(\sigma_s - 1)}} \left(\frac{x_s^i}{x_s^j} \right)^{\frac{\omega_s^{ij}}{\theta}}. \qquad \text{(A7)}$$

The final term appearing above can be simplified as:

$$\exp\left\{ \ln \prod_{s=1}^{S} \left(\frac{x_s^i}{x_s^j} \right)^{\frac{\omega_s^{ij}}{\theta}} \right\} = \exp\left\{ \sum_{s=1}^{S} \left(\frac{\omega_s^{ij}}{\theta} \right) \ln \left(\frac{x_s^i}{x_s^j} \right) \right\} = \exp\left\{ \frac{\sum_{s=1}^{S} (x_s^i - x_s^j)}{\theta \sum_{r=1}^{S} (x_r^i - x_r^j) / (\ln x_r^i - \ln x_r^j)} \right\} = 1, \qquad \text{(A8)}$$

where the final result is obtained because the expenditure shares in both countries sum to unity, so that $\sum_{s=1}^{S} (x_s^i - x_s^j) = 0$ and then $\exp(0) = 1$. Then (12) follows immediately. If we do not assume that θ is common across sectors, then the final term in (A7) is $\prod_{s=1}^{S} (x_s^i / x_s^j)^{\omega_s^{ij} / \theta_s}$, which does not equal unity but could be computed from the data. Then the result in (12) would be modified by this additional term.

Proof of (13):

It can be noted that the result in (A8) is precisely what is used to prove the Sato-Vartia index in (11). To see this, start with the expenditure share from (A1), $x_s^i = a_s (P_s^i / P^i)^{1-\eta}$. We readily solve for the ratio of country CES prices from this equation as:

$$\frac{P^i}{P^j} = \left(\frac{P_s^i}{P_s^j}\right)\left(\frac{x_s^i / a_s}{x_s^j / a_s}\right)^{\frac{-1}{1-\eta}}.$$

The terms a_s cancel in this expression since they are assumed to be equal across countries. Then taking the geometric mean of the expression using the Sato-Vartia weights in (12), we see that the terms involving the mean ratio of sectoral expenditure shares becomes unity, just as in (A8). Therefore, the Sato-Vartia index in (11) follows immediately.

The same approach is used to prove (13). From equation (9) we readily obtain:

$$\left(\frac{M_s^{ii}}{M_s^{jj}}\right) = \frac{\lambda_s^{ii}}{\lambda_s^{jj}}\left(\frac{X_s^i / w^i f_s^{ii}}{X_s^j / w^j f_s^{jj}}\right) = \frac{\lambda_s^{ii}}{\lambda_s^{jj}}\left(\frac{x_s^i}{x_s^j}\right)\left(\frac{L^i \ / \ f_s^{ii}}{L^j \ / \ f_s^{jj}}\right).$$

Taking the geometric mean of this expression using the Sato-Vartia weights ω_s^{ij}, and using (A8) – but without θ appearing there – we readily obtain (13). It follows that the result in (13) holds even if θ is not common across sectors, and it also does not rely on Assumption 1.

A.2 Sources and construction of data

Sato-Vartia weights:

We consider the general case of a nested CES function, where the expenditure across traded goods is aggregated using a CES function, the expenditure across the various traded sectors is aggregated using a second CES function, and then nontraded goods included within "actual individual consumption" (AIC) are added with a third CES function.

At the lowest level, the traded goods price index P_s^{Ti} is obtained from the prices of goods purchased from home, P_s^{Tii}, and those that are purchased from abroad, P_s^{Tji}, $j \neq i$:

$$P_s^{Ti} = \left[\sum_{j=1}^{C} b_s^j (P_s^{Tji})^{1-\sigma} \right]^{1/(1-\sigma)}, \ \sigma > 1. \qquad \text{(A8)}$$

This price index is comparable to what appears in (2) in our model, where the mass of products M_s^{ji} from each country in (2) is captured above by the (constant) parameter b_s^j, and we simplify with $\sigma_s = \sigma$. Above this level, the price index of traded goods P^{Ti} for country *i* is given by:

$$P^{Ti} = \left[\sum_{s=1}^{S} a_s (P_s^{Ti})^{1-\eta} \right]^{1/(1-\eta)}, \ \eta > 0,$$

as in (3). Finally, we denote the price of nontraded goods included in AIC by P^{Ni}, which could is aggregated over multiple sectors, and construct the overall price index in country *i* as:

$$P^i = \left[b_N^i (P^{Ni})^{1-\delta} + b_T^i (P^{Ti})^{1-\delta} \right]^{1/(1-\delta)}, \ \delta > 0.$$

Choose country *j* (i.e., the United States) as the base country. Then the traded goods price index in country *i* relative to *j* can be measured by the Sato-Vartia price index:

$$\frac{P^{Ti}}{P^{Tj}} = \prod_{s=1}^{S} \left(\frac{P_s^{Ti}}{P_s^{Tj}} \right)^{\omega_s^{Ti}}, \qquad \text{(A9)}$$

where the Sato-Vartia weights, $\sum_{s=1}^{S} \omega_s^{Ti} = 1$, are defined over the expenditure shares on traded goods, as in (11). Since we have already used the variable *X* to denote expenditures and *s* to denote sectors, we will use x_s to denote expenditure shares. So $x_s^{Ti} \equiv X_s^{Ti} / X^{Ti}$ is the share of expenditure on sector *s* traded goods relative to total expenditure $X^{Ti} = \sum_{s=1}^{S} X_s^{Ti}$ in country *i*. Then the Sato-Vartia weights used in (A9) are:

$$\omega_s^{Ti} \equiv \frac{(x_s^{Ti} - x_s^{Tj})}{(\ln x_s^{Ti} - \ln x_s^{Tj})} \bigg/ \left[\sum_{r=1}^{S} \frac{(x_r^{Ti} - x_r^{Tj})}{(\ln x_r^{Ti} - \ln x_r^{Tj})} \right].$$

These are the Sato-Vartia weights that appear in (14), (15) and (16) in the main text.

When we include the nontraded services that are part of AIC, the overall price index is:

$$\frac{P^i}{P^j} = \left(\frac{P^{Ti}}{P^{Tj}} \right)^{\omega_s^{Ti}} \left(\frac{P^{Ni}}{P^{Nj}} \right)^{\omega_s^{Ni}}, \qquad \text{(A10)}$$

where total AIC expenditure in country i is $X^i \equiv (X^{Ti} + X^{Ni})$ with the expenditure shares

$x^{Ti} \equiv X^{Ti} / X^i$ and $x^{Ni} \equiv X^{Ni} / X^i$, and so the Sato-Vartia weights used in (A10) are:

$$\omega^{Ti} \equiv \frac{(x^{Ti} - x^{Tj})}{(\ln x^{Ti} - \ln x^{Tj})} \bigg/ \left[\frac{(x^{Ti} - x^{Tj})}{(\ln x^{Ti} - \ln x^{Tj})} + \frac{(x^{Ni} - x^{Nj})}{(\ln x^{Ni} - \ln x^{Nj})} \right], \; \omega_s^{Ni} \equiv 1 - \omega_s^{Ti}.$$

These weights appear in (21) and (22) in the main text.

Output prices:

To construct a measure of output prices used in (14), we use the above equations and follow the framework of Inklaar and Timmer (2014). The price index P_s^{Ti} combines domestically produced goods, with price P_s^{Tii}, and imports with price P_s^{Tji} for $j \neq i$. We define P_s^{Mi} as the import price index,

$$P_s^{Mi} = \left[\sum\nolimits_{j \neq i} b_s^j (P_s^{Tji})^{1-\sigma} \right]^{1/(1-\sigma)},$$

so that the overall traded goods price index in sector s can be constructed as,

$$\frac{P_s^{Ti}}{P_s^{Tj}} = \left(\frac{P_s^{Tii}}{P_s^{Tjj}} \right)^{1-\omega_s^{Mi}} \left(\frac{P_s^{Mi}}{P_s^{Mj}} \right)^{\omega_s^{Mi}}, \qquad \text{(A11)}$$

where $x^{Tii} \equiv X^{Tii} / X^{Ti}$ and $x^{Mi} \equiv \sum_{j \neq i} X^{Tji} / X^{Ti}$ are the expenditure shares on domestic goods and imports, respectively, and the Sato-Vartia weights on imports is:

$$\omega_s^{Mi} \equiv \frac{(x_s^{Mi} - x_s^{Mj})}{(\ln x_s^{Mi} - \ln x_s^{Mj})} \Bigg/ \left[\frac{(x_s^{Tii} - x_s^{Tjj})}{(\ln x_s^{Tii} - \ln x_s^{Tjj})} + \frac{(x_s^{Mi} - x^{Mj})}{(\ln x^{Mi} - \ln x^{Mj})} \right].$$

Notice that from (A11) we construct the domestic price of tradable goods as:

$$\frac{P_s^{Tii}}{P_s^{Tjj}} = \left(\frac{P_s^{Ti}}{P_s^{Tj}} \right)^{1/(1-\omega_s^{Mi})} \left(\frac{P_s^{Mi}}{P_s^{Mj}} \right)^{-\omega_s^{Mi}/(1-\omega_s^{Mi})} . \tag{A12}$$

All these prices are inclusive of the domestic trade costs τ_s^{ii} needed to deliver a good to consumers, while import prices also include foreign trade costs . τ_s^{ji} [1] We let $\tilde{P}_s^{Tii} \equiv P_s^{Tii}/\tau_s^{ii}$ denote the prices *net* of the domestic trade costs – or what is called a "basic" price – which is the price that home producers face for domestic sales. Home firms also export, so the total value of home production Y_s^{Ti} on tradable goods equals:

$$Y_s^{Ti} \equiv P_s^{Yi} Q_s^{Yi} = \tilde{P}_s^{Tii} Q_s^{Tii} + \tilde{P}_s^{Xi} Q_s^{Xi} = \left(X_s^{Ti}/\tau_s^{ii} \right) + \tilde{P}_s^{Xi} Q_s^{Xi},$$

where $\tilde{P}_s^{Xi}$ is the export price index, the Qs denote the associated quantities, and sales to home consumers net of trade costs is $\tilde{P}_s^{Tii} Q_s^{Tii} = X_s^{Tii}/\tau_s^{ii}$. The export price index is defined using f.o.b. (free-on-board) prices net of any trade costs (i.e., net of transport costs and tariffs),

$$\tilde{P}_s^{Xi} = \left[\sum_{j \neq i} b_s^i \left(P_s^{Tij}/\tau_s^{ij} \right)^{1-\sigma} \right]^{1/1-\sigma} .$$

Assuming a CES production function for domestic consumption and exports, the output price is constructed as a Sato-Vartia index:

$$\frac{P_s^{Yi}}{P_s^{Yj}} = \left(\frac{\tilde{P}_s^{Tii}}{\tilde{P}_s^{Tjj}} \right)^{1-\omega_s^{Xi}} \left(\frac{\tilde{P}_s^{Xi}}{\tilde{P}_s^{Xj}} \right)^{\omega_s^{Xi}} , \tag{A13}$$

where $y_s^{Tii} \equiv (X_s^{Tii}/\tau_s^{ii})/Y_s^{Ti}$ and $y^{Xi} \equiv 1 - y_s^{Tii}$ are the production shares on domestic goods

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[1] For simplicity, we assume that domestic trade costs are identical for domestically produced and imported goods.

and exports, respectively, and the associated Sato-Vartia weight on exports is:

$$\omega_s^{Xi} \equiv \frac{(y_s^{Xi} - y_s^{Xj})}{(\ln y_s^{Xi} - \ln y_s^{Xj})} \Bigg/ \left[\frac{(y_s^{Tii} - y_s^{Tjj})}{(\ln y_s^{Tii} - \ln y_s^{Tjj})} + \frac{(y_s^{Xi} - y_s^{Xj})}{(\ln y_s^{Xi} - \ln y_s^{Xj})} \right]. \tag{A14}$$

Substituting (A12) and $\tilde{P}_s^{Tii} \equiv P_s^{Tii}/\tau_s^{ii}$ into (A13) we obtain the price of output:

$$\begin{aligned} \frac{P_s^{Yi}}{P_s^{Yj}} &= \left(\frac{P_s^{Ti}}{P_s^{Tj}}\right)^{\frac{1-\omega_s^{Xi}}{1-\omega_s^{Mi}}} \left(\frac{\tau_s^{ii}}{\tau_s^{jj}}\right)^{-(1-\omega_s^{Xi})} \left(\frac{\tilde{P}_s^{Mi}\tau_s^{ii}}{\tilde{P}_s^{Mj}\tau_s^{jj}}\right)^{-\frac{\omega_s^{Mi}(1-\omega_s^{Xi})}{1-\omega_s^{Mi}}} \left(\frac{\tilde{P}_s^{Xi}}{\tilde{P}_s^{Xj}}\right)^{\omega_s^{Xi}} \\ &= \left(\frac{P_s^{Ti}/\tau_s^{ii}}{P_s^{Tj}/\tau_s^{jj}}\right)^{\frac{1-\omega_s^{Xi}}{1-\omega_s^{Mi}}} \left(\frac{\tilde{P}_s^{Xi}}{\tilde{P}_s^{Xj}}\right)^{\omega_s^{Xi}} \left(\frac{\tilde{P}_s^{Mi}}{\tilde{P}_s^{Mj}}\right)^{-\frac{\omega_s^{Mi}(1-\omega_s^{Xi})}{1-\omega_s^{Mi}}}, \end{aligned} \tag{A15}$$

where the first line comes from using $\tilde{P}_s^{Tii} \equiv P_s^{Tii}/\tau_s^{ii}$ and (A12), while letting $\tilde{P}_s^{Mi} \equiv P_s^{Mi}/\tau_s^{ii}$ denote the c.i.f. prices of imports inclusive of tariffs but net of *domestic* trade costs, and the second line follows from simplification.

The price indexes that we have constructed so far are the theoretically correct CES indexes. To relate these to the price level that we construct from ICP and PWT data, let us start with (A9). The price ratio on the left is what we measure as the price level of consumption for traded goods, so we replace P_s^{Ti} / P_s^{Tj} with PC_s^{Ti} / PC_s^{Tj}. This price level of consumption also appears first on both lines of (A15). In that case, the price of output P_s^{Yi} / P_s^{Yj} appearing on the left of (A15) is replaced with PY_s^{Ti} / PY_s^{Tj}, as in (15) in the main text. Finally, the export and import prices $\tilde{P}_s^{Xi}/\tilde{P}_s^{Xj}$ and $\tilde{P}_s^{Mi}/\tilde{P}_s^{Mj}$ are measured by the quality-adjusted export and imports prices from Feenstra and Romalis (2014), for $j = USA$.

To implement the resulting equations which appear as (15) and (16) in the main text, we draw on the World Input-Output Tables (Timmer et al., 2015, 2016) for calculating the Sato-Vartia weights for import and export shares. For Colombia, Chile, New Zealand and South Africa, we use the data from the OECD TiVA tables. The traded consumption prices are the same as discussed in the main text, aggregated from the (revised) ICP 2011 PPPs and consumption expenditure data using GEKS indexes. The import and export price data are organized by SITC rev. 2, so first we use the concordance to the Broad Economic Category (BEC-4) classification to select only traded products consumed by households.[2] Second, we use the concordance between 4-digit SITC rev. 2 and 3-digit ISIC rev. 2 constructed by Marc Muendler,[3] and bridge that to ISIC rev. 4, the industry classification used in WIOD and OECD TiVA. We aggregate to ISIC rev. 4 industries using export values from Comtrade and GEKS indexes. In the final step, we use export values by ISIC rev. 4 industry from WIOD and OECD TiVA to aggregate to the traded consumption sectors.

Other data:

Other data used in (14) is obtained as follows. The share of consumption expenditure on domestic products, λ_s^{ii}, is computed based on WIOD. Colombia, Chile, New Zealand and South Africa are not in WIOD, so we use the inter-country input-output tables of OECD TiVA to compute λ_s^{ii} for those countries. Domestic trade costs τ_s^{ii} in sector s are measured as consumption expenditure at purchaser's prices divided by consumption expenditure at basic prices, which excludes the margin earned in transportation and retail trade and excludes taxes on products, notably sales tax, VAT and excise taxes. For most countries, we rely on the margins and tax tables (sometimes also referred to as valuation tables) provided by Eurostat and the OECD, which report consumption at purchaser's prices and at basic prices. For the remainder of countries, we use data from national input-output tables, from Eurostat's Structural Business

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[2] We select food and beverages, mainly for household consumption, primary (BEC code 112) and processed (122); processed fuels and lubricants (32), transport equipment, passenger motor cars (51) and consumption goods (6). This selection means that products used by industry, as supplies or capital goods, are omitted.

[3] https://econweb.ucsd.edu/muendler/docs/conc/sitc2isic.pdf.

Statistics for retail trade, or WIOD to approximate trade margins.[4] To estimate consumption taxes by sector, we use information on total taxes on products by sector and ensure that the tax rate (taxes as a share of consumption expenditure at purchaser's prices) does not exceed that country's indirect tax rates.[5]

A.3 Product Variety

Firm and Barcode Counts:

In Appendix Table A1 we show the Orbis firm counts in seven sectors and 46 countries. In Appendix Table A2, we show the barcode counts computed from the data available at the Billion Prices Project, in five sectors and 24 countries. Note, however, that these barcode counts include both domestically produced and imported goods. As explained in section 3.2, we adjust these barcode codes to obtain just *domestically produced* barcodes by collecting the *barcode domestic share*, which was obtained in two different ways

Our main measure of the barcode domestic share uses data collected by freelancers in physical stores of large retailer, or what we refer to as the crowdsourcing method. The first columns in Table A3 provide details of this data collection effort in 19 countries. In some countries we hired multiple freelancers to collect data from several large companies. The freelancers took photos of the product labels (see example shown in Figure A1), which we then

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[4] We rely on national input-output data for China, Japan, Indonesia, New Zealand, Russia, South Africa, Taiwan; Eurostat retail survey data for Germany, Spain and Switzerland; and WIOD data for India. The retail survey data abstracts from transportation margins, but most transportation costs are registered as intermediate inputs rather than as margins.

[5] Country-level indirect tax rates are from the OECD Consumption Tax Trends 2018 publication. On average across European countries with the requisite data, only 60 percent of taxes on products are borne directly by consumers, so scaling is important. Excise taxes on alcoholic beverages, tobacco and fuel lead to higher tax rates in the food and transport sectors so in those sectors, the tax rate is allowed to exceed the national indirect tax rate, though not by more than the maximum excess rate observed in other European countries. In Japan, a uniform VAT rate of 5 percent is applied to all sectors, which is increased by an additional 5.8 percent in the food and transport sectors based on estimates of the revenue from excise taxes relative to VAT in the OECD Consumption Tax Trends 2018 publication.

used to monitor and validate their work. A more detailed description of the mobile-phone app used by the freelancers can be found on Cavallo (2017).

Appendix Figure A1: Example of a Crowdsourced Product Image

Notes: Freelancers were instructed to take a photograph of the package's country-of-origin information. In this example taken inside a German electronics retailer, the product is made in China.

The crowdsourcing method makes it possible to collect country-of-origin data from many locations, but it also limited us to a relatively small sample of about 1000 products in each country (500 food products and 500 electronic product). As a robustness check, we were also able to collect web-scraped data from the websites of retailers that show the country-of-origin information for individual goods. These online estimates are only available for 9 food and 2 electronics retailers (covering 10 countries), but the product samples are much larger because they include all goods available for sale in these companies. The last columns of Table A3 show the number of domestic and imported varieties using this online scraped data. The barcode domestic ratios are very similar, with a correlation 0.76 between the benchmark offline (crowdsourced) and online estimates.

As a final robustness check, we also estimated the domestic barcode ratio for food in the US using Nielsen' Scanner data, shown in the last column of Table A3. Reassuringly, the barcode domestic ratio is 0.86 with scanner data, 0.90 with online scraped data, and 0.89 with the crowdsourced data.

In Appendix Table A4 we compare the firm counts and barcode counts for the 23 countries where both are available (Colombia does not have firm counts). The first data column in Table A3 lists the count of domestic firms when summed across 7 sectors, and the second column lists the count of barcode for 5 sectors for which data are available from BPP, that are likewise summed across sectors. Those barcode counts in the second column (labeled *total N*) include both domestically produced and imported goods. We use the domestic barcode ratios B, summarized in Table A3, to compute the number of domestic barcodes in Table A4 as $M = NB$ for the sectors in Food & Beverages and in Recreation & Culture (mainly Electronics goods). Outside of these two sectors, we instead use the domestic expenditure share $\boldsymbol{\lambda}$ to compute the number of domestic barcodes as $\boldsymbol{M = N\lambda}$, as explained in section II.B. Then the number of domestic barcodes summed across 5 sectors is shown in the third data column of Table A4.

It can be seen from Table A4 that the number of firms (in 5 sectors) can be greater or less than the number of domestic barcodes (in 5 sectors). Specifically, the number of firms exceeds the number of domestic barcodes in 10 countries and is less than the number of barcodes in 13 countries. Having more firms than barcodes in these sectors can occur because some of the firms might exclusively produce intermediate inputs, while having more barcodes than firms can occur because of multiproduct firms. Furthermore, we see that for Ireland, the number of firms in the 5 sectors is roughly 100x smaller than in the United States ($2{,}991/329{,}389 \approx 0.01$), but the number of domestic barcodes is only 10x smaller ($15{,}646/184{,}974 \approx 0.1$). A similar pattern holds for New Zealand, where both domestic barcodes and firms counts are roughly 3x higher than in Ireland. Evidently, the surviving firms in these small and very open countries have more product varieties per firm, on average, than in a large and less-open country like the United States (as suggested by the theoretical results in Feenstra and Ma, 2009).

Appendix Table A1. Orbis Firm Counts in 46 Countries

Sector	Food & beverages	Clothing & footwear	Furnishing & household eq.	Health	Transportation	Recreation & culture	Other goods & services
COICOP	01-02	03	05	06	07	09	12
Australia	18,315	7,954	10,152	926	3,947	21,352	836
Austria	5,416	3,316	5,841	315	725	3,096	199
Belgium	15,361	6,910	7,274	2,040	1,326	14,775	395
Brazil	31,524	30,127	29,188	2,271	5,616	38,407	3,689
Bulgaria	12,144	10,692	4,652	90	184	2,679	810
Canada	5,595	3,458	10,927	1,071	1,822	14,037	1,207
Chile	3,676	1,290	1,153	58	97	1,369	118
China	61,415	56,998	47,803	6,684	19,681	74,328	15,590
Croatia	4,165	2,332	1,969	66	161	2,584	321
Cyprus	784	280	323	13	45	264	37
Czechia	21,975	23,053	36,497	111	1,078	13,023	441
Denmark	2,330	804	1,491	155	163	1,545	140
Estonia	1,262	1,700	1,373	27	105	995	90
Finland	3,534	5,199	3,207	75	445	4,062	218
France	28,419	5,561	7,384	447	1,649	10,800	1,024
Germany	19,856	5,191	17,666	1,776	2,991	26,788	1,793
Greece	2,503	992	769	130	56	873	284
Hungary	8,518	5,910	5,717	153	653	6,841	1,672
India	15,945	11,074	6,927	9,829	3,242	9,224	1,437
Indonesia	1,717	1,425	1,404	376	471	2,647	373
Ireland	1,608	436	869	237	209	1,635	51
Italy	45,299	62,181	27,315	719	2,690	21,045	2,918
Japan	21,175	5,714	11,724	698	4,040	18,549	4,094
Korea	16,679	8,928	11,185	1,155	10,147	27,288	3,511
Latvia	1,300	1,203	1,119	49	74	899	113
Lithuania	1,305	1,171	1,403	31	58	632	129
Luxembourg	229	39	86	10	20	162	7
Malta	90	22	66	23	6	70	7
Mexico	9,914	6,347	5,947	793	2,358	5,364	1,530
Netherlands	8,173	5,196	11,810	428	927	7,599	401
New Zealand	5,079	1,001	1,477	245	507	2,170	112
Norway	3,605	3,548	2,554	69	170	2,753	77
Poland	14,740	13,183	15,117	498	1,505	10,034	2,490
Portugal	8,477	8,875	4,911	178	551	2,781	434
Romania	18,805	12,261	7,706	158	532	4,338	1,003
Russia	60,918	50,262	49,429	1,162	2,074	29,265	2,777
Slovakia	4,525	4,763	4,859	36	522	3,537	307
Slovenia	3,075	1,397	2,175	38	230	2,028	187
South Africa	17,921	4,269	4,941	788	707	7,579	1,293
Spain	21,845	12,811	12,563	510	1,881	14,150	1,210
Sweden	2,681	699	2,502	160	657	2,896	188
Switzerland	5,920	2,945	2,867	544	317	6,150	186
Taiwan	7,768	3,903	12,912	459	1,650	15,698	2,236
Turkey	13,550	17,559	18,552	838	3,023	11,165	1,553
United Kingdom	22,919	13,892	18,259	1,704	4,786	26,748	2,816
United States	56,689	28,022	95,313	10,917	19,661	140,302	9,063

Appendix Table A2. BPP Barcode Counts by Sector in 24 Countries

Sector COICOP	Food & beverages 01-02	Clothing & footwear 03	Furnishing & household eq. 05	Recreation & culture 09	Other goods & services 12
Australia	9,738	64,319	11,513	29,217	3,205
Brazil	7,721	11,493	133,418	70,128	14,844
Canada	13,502	17,224	38,401	30,910	9,969
Chile	3,680	16,205	25,516	6,810	8,911
China	22,123	87,193	59,736	23,065	19,662
Colombia	5,707	15,975	13,003	5,694	3,515
Germany	15,860	26,219	87,676	98,334	22,678
Spain	12,741	60,832	43,763	35,568	23,077
France	11,235	26,766	183,281	23,793	3,782
United Kingdom	11,996	39,254	26,142	19,880	13,237
Greece	4,454	7,236	30,092	11,678	5,989
India	4,039	38,675	4,091	2,019	1,614
Ireland	9,162	8,896	11,389	3,005	7,636
Italy	7,819	13,434	41,214	14,348	3,248
Japan	16,163	136,015	160,810	165,692	85,293
Korea	41,641	47,999	95,512	42,891	26,467
Mexico	7,789	17,137	17,269	7,275	7,626
Netherlands	12,038	38,104	42,526	17,533	12,634
New Zealand	7,006	11,613	26,341	20,800	8,591
Poland	7,927	1,221	19,268	28,590	3,784
Russia	7,821	13,755	38,533	21,049	3,567
Turkey	6,753	37,719	32,532	8,910	11,244
United States	22,386	57,305	185,983	80,598	29,671
South Africa	9,493	4,901	10,182	14,152	11,150

Appendix Table A3. Offline and Online Data Collection for Estimating the Share of Domestic Barcodes

		Mobile Phone Data Collection						Online Scraped Data				Scanner Data
Country	Type	Workers	Retailers	Barcodes	Domestic	Imported	Share Domestic Barcode	Barcode Online	Domestic Online	Imported Online	Share Domestic Online	Share Domestic (Nielsen)
AUS	Food	1	2	482	294	188	0.61	14,829	11,249	3,580	0.76	
BRA	Food	4	4	478	430	48	0.90	12,293	10,392	1,901	0.85	
CAN	Food	1	2	408	230	178	0.56					
CHN	Food	2	2	517	397	120	0.77	21,843	17,932	3,911	0.82	
DEU	Food	2	3	513	448	65	0.87	26,808	21,157	5,651	0.79	
ESP	Food	4	5	419	280	139	0.67					
FRA	Food	4	7	472	392	80	0.83					
GBR	Food	3	5	547	426	121	0.78					
GRC	Food	3	6	585	475	110	0.81					
IND	Food	3	4	206	204	2	0.99					
IRL	Food	3	4	423	268	155	0.63	9,219	5,926	3,293	0.64	
ITA	Food	4	3	420	374	46	0.89	7,881	6,620	1,261	0.84	
JPN	Food	1	8	508	447	61	0.88					
MEX	Food	4	7	346	276	70	0.80					
NLD	Food	1	5	501	337	164	0.67	5,593	1,891	3,702	0.34	
POL	Food	1	2	384	205	179	0.53					
RUS	Food	3	3	533	377	156	0.71	21,900	12,538	9,362	0.57	
TUR	Food	2	3	513	402	111	0.78					
USA	Food	3	3	509	454	55	0.89	23,259	21,035	2,224	0.90	0.86
AUS	Electronics	1	6	1035	15	1020	0.01	4,474	92	4,382	0.02	
BRA	Electronics	4	7	487	235	252	0.48					
CAN	Electronics	1	3	435	44	391	0.10					
CHN	Electronics	1	3	516	510	6	0.99					
DEU	Electronics	3	7	502	162	340	0.32					
ESP	Electronics	4	5	382	78	304	0.20					
FRA	Electronics	3	5	502	53	449	0.11					
GBR	Electronics	1	2	308	60	248	0.19					
GRC	Electronics	3	3	411	52	359	0.13					
IRL	Electronics	3	2	150	20	130	0.13					
JPN	Electronics	1	4	420	66	354	0.16					
MEX	Electronics	3	8	428	46	382	0.11					
NLD	Electronics	1	1	505	89	416	0.18					
POL	Electronics	3	3	467	158	309	0.34					
RUS	Electronics	2	3	391	42	349	0.11					
TUR	Electronics	5	7	445	168	277	0.38					
USA	Electronics	4	6	410	97	313	0.24	6,596	2,477	4,119	0.38	

Notes: This Table shows details for the crowdsourcing data collection to estimate the share of domestic varieties in Food and Electronics. The first columns show the number of workers (freelancers hired), the number of retailers they visited, the number of barcodes they collected, and whether the products were domestically produced or imported. If the product packaging showed a foreign country of origin, the barcode was classified as foreign. The share of domestic barcodes is computed as domestic barcodes over total barcodes. The columns labelled "Online Scraped Data" show details on a complementary data collection carried out online, in a single retailer per sector and country, but with the advantage of much large product samples. The last column shows a similar domestic share estimate computed for Food in the US using Nielsen's scanner data.

Table A4: Number of Firms and Domestic Varieties

Country	Orbis Firm Count (7 Sectors)	Orbis Firm Count (5 sectors)	# Barcodes (5 Sectors, *total N*)	#Domestic Barcodes (5 Sectors, *M*)	Food & Beverages		Recreation & Culture (Electronics)	
					# Barcodes (*N*)	Share Domestic Barcodes (*B*)	# Barcodes (*N*)	Share Domestic Barcodes (*B*)
Australia	63,482	58,609	117,992	41,134	9,738	0.61	29,217	0.01
Brazil	140,822	132,935	237,604	189,268	7,721	0.90	70,128	0.48
Canada	38,117	35,224	110,006	33,155	13,502	0.56	30,910	0.10
Chile	8,253	7,606	61,122	28,418	3,680	-	6,810	-
China	282,499	256,134	211,779	188,952	22,123	0.77	23,065	0.99
France	55,284	53,188	248,857	82,430	11,235	0.83	23,793	0.11
Germany	76,061	71,294	250,767	102,415	15,860	0.87	98,334	0.32
Greece	5,607	5,421	59,449	26,479	4,454	0.81	11,678	0.13
India	57,678	44,607	50,438	48,302	4,039	0.99	2,019	-
Ireland	5,045	2,991	40,088	15,646	9,162	0.63	3,005	-
Italy	162,167	158,758	80,063	41,924	7,819	0.89	14,348	0.13
Japan	65,994	61,256	563,973	266,783	16,163	0.88	165,692	0.16
Korea	78,893	67,591	254,510	180,931	41,641	-	42,891	-
Mexico	32,253	29,102	57,096	34,117	7,789	0.80	7,275	0.11
Netherlands	34,534	33,179	122,835	19,518	12,038	0.67	17,533	0.18
New Zealand	11,460	9,839	74,351	43,301	7,006	-	20,800	-
Poland	57,567	55,564	60,790	27,291	7,927	0.53	28,590	0.34
Russia	195,887	192,651	84,725	43,652	7,821	0.71	21,049	0.11
South Africa	45,695	36,003	49,878	35,499	9,493	-	14,152	-
Spain	64,970	62,579	175,981	72,612	12,741	0.67	35,568	0.20
Turkey	66,240	62,379	97,158	73,148	6,753	0.78	8,910	0.38
United King.	91,124	84,634	110,509	29,924	11,996	0.78	19,880	0.19
United States	359,967	329,389	375,943	184,974	22,386	0.89	80,598	0.24

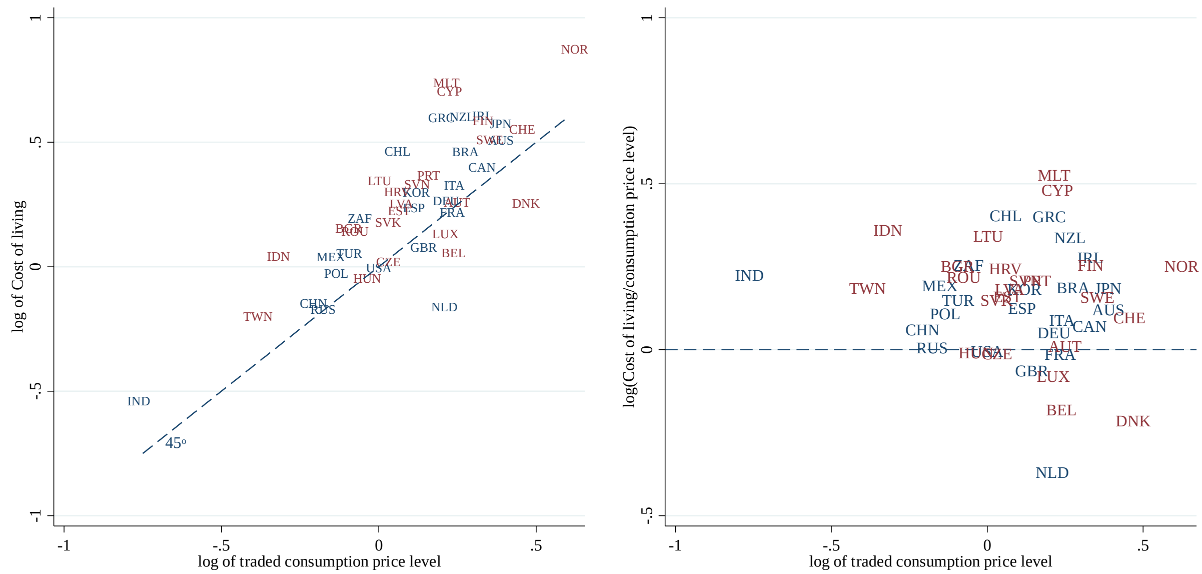
Notes: This table compares the firm and barcode counts by country. The second column shows the total count of firms from the Orbis database for 7 sectors of tradable goods (see Table 1). The third and fourth columns restrict the sample to 5 sectors (excluding Health and Transportation) where there we have both Orbis firm counts, and barcode counts from the Billion Price Project. These variables are plotted again country populations in Figure 1 in the main text. Also shown here are the domestic barcode shares collected for Food & Beverages and for Recreation & Culture (mainly Electronics).

A.4 Additional Figures

Results using Firm Counts and Barcode Counts Separately

Figure A2 shows the estimates of the cost of living for 46 countries based on the firm count data. The variety effect increases the cost of living in all countries relative to the United States, which has nearly the greatest variety. As a result, most countries have a greater cost of living relative to the US than indicated by their relative consumption prices (second panel). Only Belgium, Denmark, Luxembourg, the Netherlands and the United Kingdom (GBR) have a cost of living relative to the US that is lower than their traded consumption price level. A group of

Figure A2. Cost of living versus the traded consumption price level – firm count data

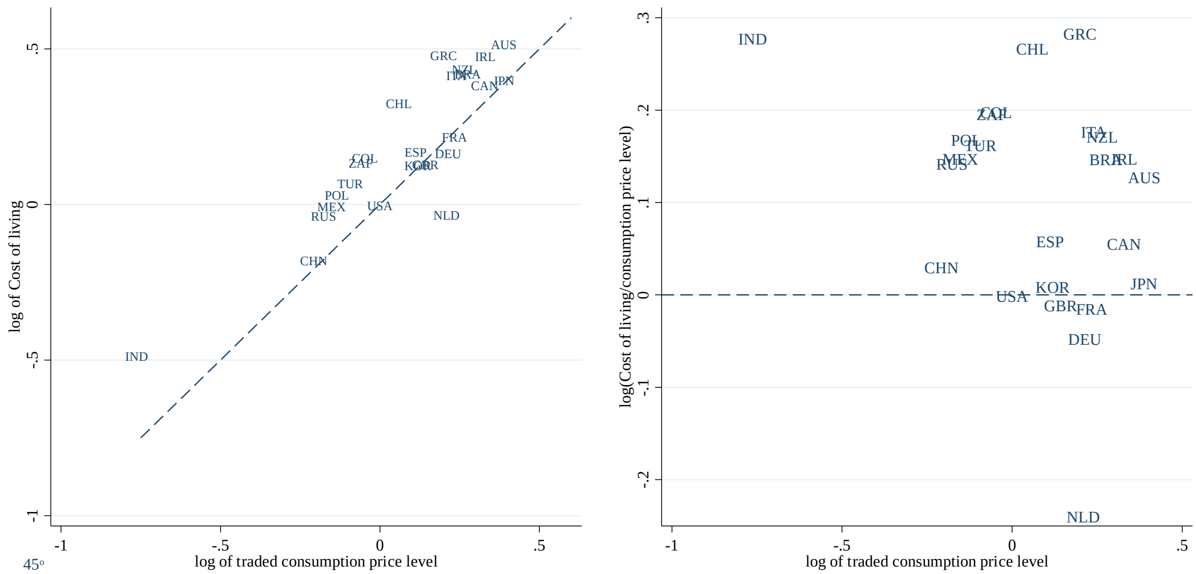


Notes: The left-hand figure plots $\ln CoL^{Ti}$ versus $\ln PC_c^{Ti}$ for the 46 countries in our analysis with firm count data, with $\ln CoL^{Ti}$ as defined in equation (14) and $\ln PC_c^{Ti}$ computed as the price level of traded consumption, with PC^{Ti} and CoL^{Ti} normalized to USA=1. The right-hand figure plots $\ln(CoL^{Ti}/PC^{Ti})$ versus $\ln PC^{Ti}$. Countries in blue are covered by both firm count data and barcode data, while observations in red are only in the firm count data.

other countries have relative costs of living that are insignificantly different from their relative consumption prices, based on the 95% confidence intervals for the cost of living shown in the second panel. This group includes Russia and several countries in Europe: Austria, Czech Republic, France, Hungary, and Germany.

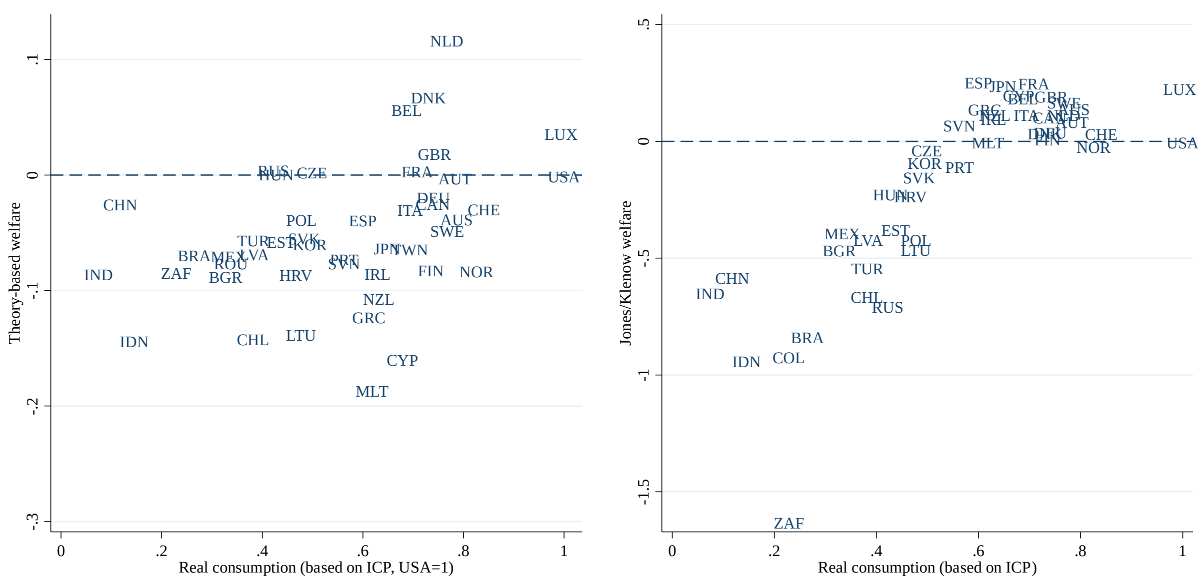
Figure A3 shows the results based on the barcode data for the 24 countries with available data. Here, too, most countries have a higher cost of living relative to the US than their consumption price level, with only France, Germany, the Netherlands and the United Kingdom at a lower level. Figure A4 shows the ratio of theory-based real consumption calculated using firm count data for all 46 countries to actual real consumption using ICP prices. A difference between Figure A4 and Figure 7 (which uses mixed barcode and firm counts) occurs for Russia,

Figure A3. Cost of Living versus the Traded Consumption Price Level – barcode data



Notes: The left-hand figure plots $\ln CoL^{Ti}$ versus $\ln PC_c^{Ti}$ for the 23 countries in our analysis with barcode data, with $\ln CoL^{Ti}$ as defined in equation (14) and $\ln PC_c^{Ti}$ computed as the price level of traded consumption, with PC^{Ti} and CoL^{Ti} normalized to USA=1. The right-hand figure plots $\ln(CoL^{Ti}/PC^{Ti})$ versus $\ln PC^{Ti}$.

Figure A4. Ratio of theory-based real consumption to actual real consumption using ICP prices, versus actual real consumption – firm count data



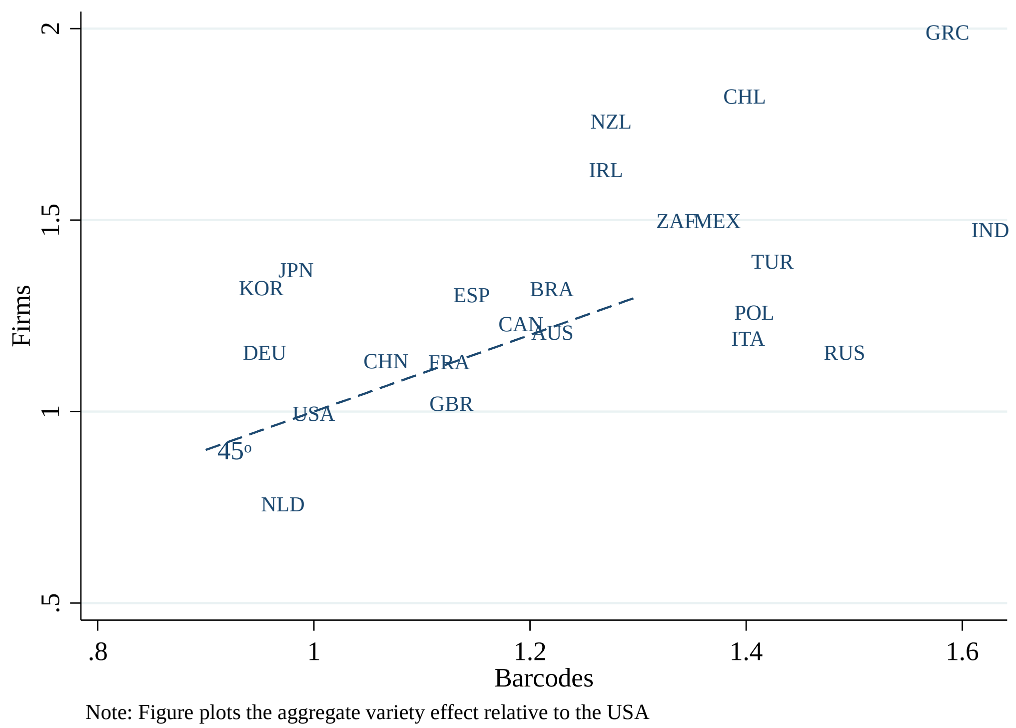
Notes: The left-hand figure plots the log of the ratio of theory-based real consumption (using firm counts) to actual real consumption (based on ICP prices), against log real consumption, for 43 countries in our sample. The right-hand panel plots the log of ratio of welfare from Jones and Klenow (2016) to actual real consumption (based on ICP prices), against log real consumption, for the matching 43 countries in their sample.

which has welfare comparable to real consumption in Figure A4 using firm counts, but lower welfare in Figure 7 using barcode counts.

Results using Low Parameter Estimates:

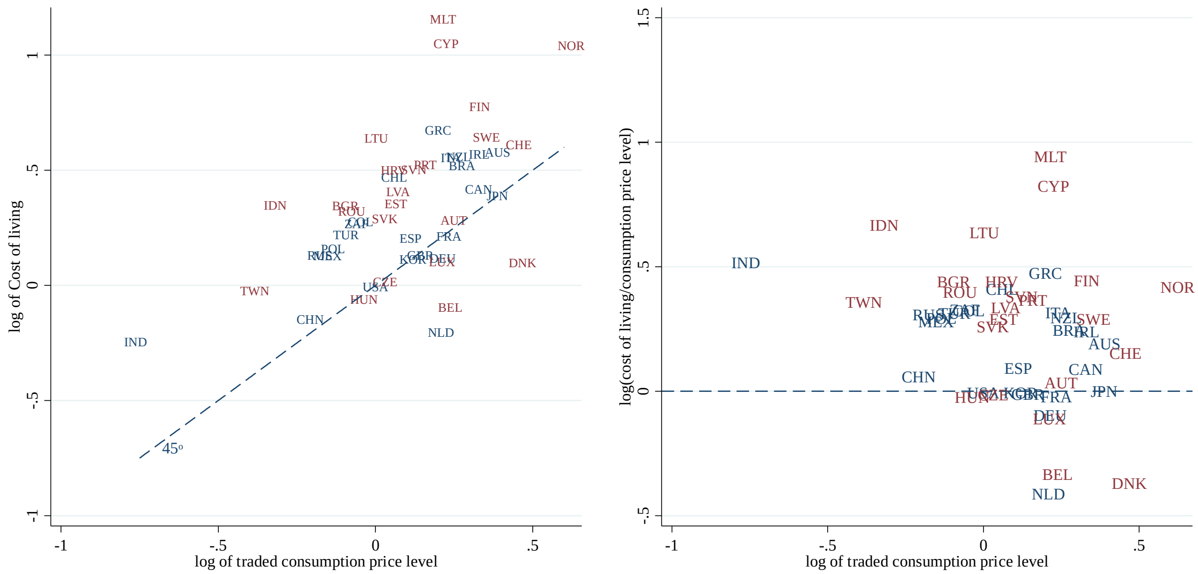
In Appendix Figures A5, A6 and A7, we re-compute Figures 5, 6 and 7 but using low parameter estimates $(\sigma, \theta) = (3.9, 5.1)$. We find that Figures A5, A6 and A7 have a very similar qualitative pattern to Figures 5, 6 and 7, but with values on the vertical axis (and the horizontal axis for Figure A5) that are roughly 1.5–2 times greater than those in Figures 5, 6 and 7, which used the higher parameter values $(\sigma, \theta) = (6.5, 8.3)$.

Figure A5: Variety effects by country – firm count versus barcode count (USA=1), low parameter values



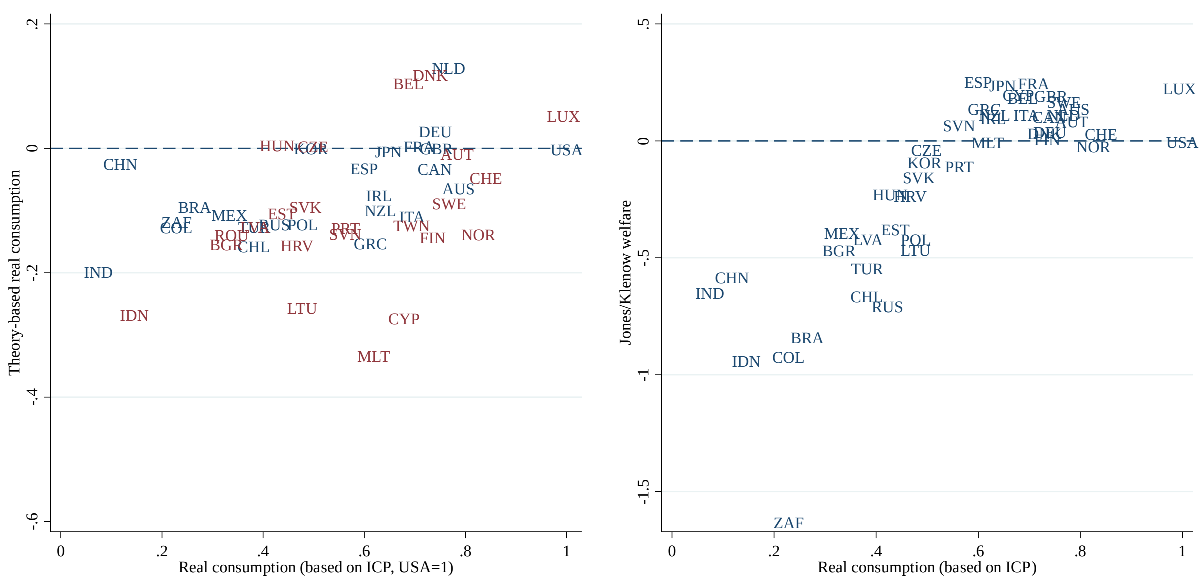
Note: Figure plots the aggregate variety effect relative to the USA

Figure A6. Cost of living versus the traded consumption price level, low parameter values



Notes: See notes to Figure 6, which uses the high parameter estimates $(\sigma, \theta) = (6.5, 8.3)$ to obtain the cost of living. This Appendix Figure A6 uses the low estimates $(\sigma, \theta) = (3.9, 5.1)$.

Figure A7. Ratio of theory-based real consumption to real consumption using ICP prices, versus real consumption – firm count data



Notes: See notes to Figure 7, which uses the high parameter estimates $(\sigma, \theta) = (6.5, 8.3)$ to obtain the theory-based real consumption. This Appendix Figure A7 uses the low estimates $(\sigma, \theta) = (3.9, 5.1)$.

A.5 Decomposition of Results

In Appendix Tables A5 and A6, we show the log values of the terms in (16) to provide a decomposition of the ratio of the cost of living to the consumption price. Table A5 uses the firm counts, and Table A6 use the barcode counts.

Appendix Table A5. Traded consumption prices, the cost of living and a decomposition, Orbis firm counts

Country	ISO-code	PC	CoL	$\ln(CoL/PC)$	Due to:			
					Trade costs and terms of trade	Inverse openness	Variety	Sectoral Share
India	IND	0.466	0.586	0.229	0.000	0.047	0.206	-0.034
				[0.203, 0.269]			[0.181, 0.247]	
Taiwan	TWN	0.682	0.824	0.189	-0.011	-0.009	0.182	0.027
				[0.152, 0.248]			[0.146, 0.241]	
Indonesia	IDN	0.727	1.047	0.364	0.024	0.017	0.350	-0.026
				[0.304, 0.462]			[0.289, 0.447]	
China	CHN	0.813	0.867	0.065	-0.007	0.041	0.068	-0.037
				[0.064, 0.067]			[0.067, 0.070]	
Russia	RUS	0.838	0.847	0.010	-0.039	0.003	0.078	-0.031
				[-0.004, 0.032]			[0.064, 0.100]	
Mexico	MEX	0.859	1.046	0.197	0.002	0.012	0.215	-0.033
				[0.160, 0.256]			[0.178, 0.274]	
Poland	POL	0.874	0.978	0.112	0.038	-0.032	0.123	-0.017
				[0.080, 0.164]			[0.091, 0.175]	
Bulgaria	BGR	0.909	1.174	0.256	0.054	-0.022	0.238	-0.014
				[0.205, 0.338]			[0.187, 0.320]	
Turkey	TUR	0.911	1.062	0.153	-0.004	0.016	0.176	-0.035
				[0.125, 0.200]			[0.148, 0.222]	
Romania	ROU	0.927	1.158	0.222	0.024	-0.006	0.208	-0.004
				[0.181, 0.288]			[0.167, 0.274]	
South Africa	ZAF	0.942	1.221	0.249	0.045	0.008	0.215	-0.008
				[0.221, 0.321]			[0.177, 0.276]	
Hungary	HUN	0.965	0.960	-0.005	0.049	-0.109	0.076	-0.021
				[-0.050, 0.068]			[0.031, 0.149]	
United States	USA	1.000	1.000	0.000	0.000	0.000	0.000	0.000
Lithuania	LTU	1.003	1.420	0.347	0.034	-0.035	0.365	-0.017
				[0.269, 0.473]			[0.286, 0.491]	
Slovakia	SVK	1.031	1.202	0.154	0.054	-0.075	0.180	-0.005
				[0.099, 0.242]			[0.125, 0.268]	
Czechia	CZE	1.031	1.024	-0.007	0.021	-0.080	0.055	-0.003
				[-0.040, 0.046]			[0.022, 0.108]	
Croatia	HRV	1.060	1.360	0.249	0.047	-0.042	0.264	-0.019
				[0.187, 0.348]			[0.202, 0.363]	

Country	ISO-code	PC	CoL	$\ln(CoL/PC)$	Due to:			
					Trade costs and terms of trade	Inverse openness	Variety	Sectoral Share
Chile	CHL	1.061	1.598	0.409	0.108	-0.031	0.318	0.014
				[0.341, 0.519]			[0.249, 0.428]	
Estonia	EST	1.068	1.258	0.164	0.052	-0.119	0.222	0.010
				[0.089, 0.285]			[0.146, 0.343]	
Latvia	LVA	1.074	1.295	0.187	0.047	-0.106	0.245	0.002
				[0.111, 0.309]			[0.169, 0.367]	
Spain	ESP	1.118	1.273	0.129	0.027	-0.011	0.142	-0.028
				[0.100, 0.177]			[0.112, 0.190]	
South Korea	KOR	1.127	1.357	0.186	0.015	0.019	0.150	0.002
				[0.163, 0.222]			[0.127, 0.186]	
Slovenia	SVN	1.130	1.398	0.213	0.046	-0.064	0.250	-0.019
				[0.148, 0.318]			[0.185, 0.355]	
United Kingdom	GBR	1.153	1.086	-0.060	0.013	-0.067	0.012	-0.019
				[-0.082, 0.025]			[-0.008, 0.048]	
Portugal	PRT	1.172	1.450	0.213	0.052	-0.029	0.212	-0.022
				[0.165, 0.290]			[0.164, 0.290]	
Greece	GRC	1.221	1.830	0.405	0.075	-0.011	0.364	-0.024
				[0.333, 0.520]			[0.293, 0.480]	
Netherlands	NLD	1.232	0.855	-0.366	0.023	-0.243	-0.142	-0.004
				[-0.408, -0.298]			[-0.184, -0.074]	
Luxembourg	LUX	1.236	1.146	-0.076	0.045	-0.274	0.170	-0.018
				[-0.185, 0.100]			[0.061, 0.346]	
Germany	DEU	1.238	1.310	0.056	0.016	-0.041	0.078	0.003
				[0.030, 0.098]			[0.052, 0.120]	
Malta	MLT	1.240	2.107	0.530	0.091	-0.076	0.525	-0.010
				[0.410, 0.723]			[0.405, 0.718]	
Cyprus	CYP	1.252	2.034	0.485	0.111	-0.052	0.410	0.017
				[0.394, 0.632]			[0.318, 0.557]	
France	FRA	1.264	1.251	-0.010	0.016	-0.072	0.066	-0.020
				[-0.043, 0.043]			[0.033, 0.119]	
Belgium	BEL	1.269	1.063	-0.177	0.043	-0.152	-0.049	-0.019
				[-0.211, 0.123]			[-0.083, 0.005]	
Italy	ITA	1.271	1.395	0.093	0.027	-0.001	0.094	-0.027
				[0.076, 0.122]			[0.076, 0.123]	
Austria	AUT	1.283	1.303	0.015	0.023	-0.109	0.106	-0.005
				[-0.035, 0.097]			[0.055, 0.187]	

Country	ISO-code	PC	CoL	$\ln(CoL/PC)$	Due to:			
					Trade costs and terms of trade	Inverse openness	Variety	Sectoral Share
New Zealand	NZL	1.303	1.836	0.343	0.023	-0.008	0.299	0.029
				[0.284, 0.436]			[0.240, 0.392]	
Brazil	BRA	1.317	1.596	0.192	0.030	0.044	0.149	-0.031
				[0.176, 0.217]			[0.133, 0.174]	
Canada	CAN	1.389	1.497	0.075	0.036	-0.062	0.111	-0.010
				[0.037, 0.136]			[0.072, 0.172]	
Ireland	IRL	1.392	1.844	0.282	0.048	-0.077	0.259	0.051
				[0.211, 0.395]			[0.189, 373]	
Finland	FIN	1.393	1.806	0.259	0.054	-0.047	0.226	0.026
				[0.203, 0.349]			[0.170, 0.316]	
Sweden	SWE	1.424	1.675	0.162	0.032	-0.084	0.190	0.024
				[0.103, 0.258]			[0.131, 0.286]	
Japan	JPN	1.474	1.783	0.190	0.022	0.015	0.168	-0.015
				[0.163, 0.234]			[0.141, 0.212]	
Australia	AUS	1.475	1.671	0.125	0.067	-0.033	0.101	-0.011
				[0.096, 0.170]			[0.073, 0.147]	
Switzerland	CHE	1.578	1.744	0.100	0.059	-0.100	0.123	0.018
				[0.049, 0.183]			[0.072, 0.206]	
Denmark	DNK	1.597	1.296	-0.209	0.036	-0.245	-0.009	0.008
				[-0.277, -0.100]			[-0.077, 0.100]	
Norway	NOR	1.865	2.410	0.257	0.086	-0.071	0.225	0.016
				[0.194, 0.357]			[0.163, 0.325]	

Notes: Decomposition by showing the natural log values of the terms in (16), when using approximately the square root of the firm counts to measure product variety. The terms in brackets appearing underneath the variety effect shown the 95% confidence interval on this effect, by varying the square root exponent on the firm count according to its 95% confidence interval. Likewise, the total effect on $\ln(CoL/PC)$ is computed according to these confidence intervals. All variables are measured relative to their values for the United States.

Appendix Table A6. Traded consumption prices, the cost of living and a decomposition, BPP barcode counts

Country	ISO-code	PC	CoL	$\ln(CoL/PC)$	Due to: Trade costs and terms of trade	Inverse openness	Variety	Sectoral Share
India	IND	0.466	0.616	0.278	0.000	0.047	0.256	-0.025
China	CHN	0.813	0.838	0.309	-0.007	0.041	0.034	-0.037
Russia	RUS	0.838	0.967	0.143	-0.039	0.003	0.211	0.032
Mexico	MEX	0.859	0.997	0.149	0.002	0.012	0.167	-0.033
Poland	POL	0.874	1.035	0.169	0.038	-0.032	0.180	-0.017
Turkey	TUR	0.911	1.073	0.163	-0.004	0.016	0.187	-0.035
South Africa	ZAF	0.942	1.147	0.197	0.045	0.008	0.152	-0.008
Colombia	COL	0.954	1.164	0.199	0.048	0.019	0.134	-0.002
United States	USA	1.000	1.000	0.000	0.000	0.000	0.000	0.000
Chile	CHL	1.061	1.388	0.268	0.108	-0.031	0.177	0.014
Spain	ESP	1.118	1.187	0.059	0.027	-0.011	0.072	-0.028
South Korea	KOR	1.127	1.138	0.010	0.015	0.019	-0.026	0.002
United Kingdom	GBR	1.153	1.142	-0.010	0.013	-0.067	0.063	-0.019
Greece	GRC	1.221	1.621	0.284	0.075	-0.011	0.243	-0.024
Netherlands	NLD	1.232	0.970	-0.239	0.023	-0.243	-0.015	-0.004
Germany	DEU	1.238	1.182	-0.046	0.016	-0.041	-0.025	0.003
France	FRA	1.264	1.246	-0.014	0.016	-0.072	0.062	-0.020
Italy	ITA	1.271	1.518	0.178	0.027	-0.001	0.178	-0.027
New Zealand	NZL	1.303	1.548	0.172	0.023	-0.008	0.128	0.029
Brazil	BRA	1.317	1.527	0.148	0.030	0.044	0.105	-0.031
Canada	CAN	1.389	1.470	0.057	0.036	-0.062	0.092	-0.010
Ireland	IRL	1.392	1.614	0.148	0.048	-0.077	0.126	0.051
Japan	JPN	1.474	1.495	0.014	0.022	0.015	-0.009	-0.015
Australia	AUS	1.475	1.677	0.129	0.067	-0.033	0.105	-0.011

Notes: Decomposition by showing the natural log values of the terms in (16), when using barcode counts to measure product variety. All variables are measured relative to their values for the United States.

A.6 Test of Assumption 1

Using the result in (13), we can begin to test whether Assumption 1 holds using additional data. Specifically, equation (13) tells us that when aggregated across sectors using the Sato-Vartia weights, the "overall" measure of product variety reflects country populations and the weighted-average fixed costs of production. Given that we have the data on "overall" product variety and population, we readily construct those fixed costs of production from (13).

Assumption 1 states that the fixed costs of production are proportional to the fixed costs of entry. Those fixed costs are not easily identified from our model, and we do not have any data to measure those fixed costs with accuracy. But we can use the "costs of doing business" from the World Bank as one way to infer these costs. These data provide a ranking of countries according to the ease of business regulations and enforcement of property rights. In 2011, for example, Singapore ranked 1st among 183 countries, the United States ranked 5th, China ranked 79th, Russia ranked 123rd, and India ranked 135th (World Bank, 2010). The higher rank numbers indicate greater cost of doing business, or higher fixed costs of entry. We compute the Spearman rank correlation of those numbers with the fixed costs of production from (13), using either Orbis firm counts or BPP barcode counts to infer domestic variety. We find rank correlations with costs of doing business of 0.32 (p=0.032) for the 45 countries where the square root of Orbis firm count data is used, and 0.57 (p=0.004) for the 24 countries for which BPP barcode counts are used. These rank correlations give us an indication that Assumption 1 is satisfied in the weak sense that the fixed costs of production are significantly correlated with the fixed costs of entry, as measured by the costs of doing business. Further data would be needed to test Assumption 1 more fully or modify it.

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