A Appendix (not for publication)

A.1 Constructing Firm Real Capital Stock Using Perpetual Inventory Approach

We compute a firm's real capital stock series using the perpetual inventory approach proposed by Brandt et al. (2012). The computation involves three steps.

In the first step, we estimate the real capital stock of a firm in its establishment year. To this end, we first calculate the firm's nominal capital stock in the establishment year, NK_E, using the investment estimates and the firm's age. Its real capital stock, RK_E, in the establishment year can be computed by deflating its initial nominal capital stock with the investment deflator from Perkins and Rawski (2008). This deflator is a chain-linked price deflator based on separate price indices for equipment, machinery, and building structures.

In the second step, we compute a firm's nominal capital stock in each year from its establishment year up to the first year it appears in our data. The calculation is done by simply multiplying the firm's initial nominal capital stock by $(1 + r_{ps})^n$, where n is the number of years since the firm was established; and r_{ps} is the average growth rate of nominal capital stock between 1993 and 1998 in province p and two-digit industry s (r_{ps}), based on information from the 1998 annual enterprise survey. The real capital stock of the firm in the first year in our sample is then computed with the perpetual inventory method, using a depreciation rate of 9% and the Perkins-Rawski deflator.

In the final step, we compute fixed investment for each year after 1998 (the first year in our sample) as the observed difference in the firm's nominal capital stock at original purchase prices. We use the same (9%) depreciation rate and the Perkins-Rawski deflator to roll the firm's real capital stock estimates forward, starting from its real capital stock estimate in the first year it appears in our data.

A.2 Theoretical Derivation

This section provides more detailed derivation of the main equations in the text.

A.2.1 Product Attribute Cutoffs

1. We first present the derivation of the product attribute cutoffs for domestic sales, $\lambda_s^*(\varphi)$, and exports, $\lambda_{sj}^*(\varphi)$. For a firm with total factor productivity φ, the consumer taste cutoff $\lambda_s^*(\varphi)$ for product s, above which the firm produces the product for domestic sales, can be obtained by solving the following zero-profit condition:

$$\pi_s(\varphi, \lambda_s^*(\varphi)) = \frac{R_s}{\sigma}\left(r^{-\beta(s)}\rho P(s)\varphi\lambda_s^*(\varphi)\right)^{\sigma-1} - f_s r^{\beta(s)} = 0, \qquad \text{(A-1)}$$

where $\pi_s(\varphi, \lambda_s^*(\varphi))$ represents the firm's profit by selling a variety of product s domestically; R_s stands for domestic expenditure spent on product s. $P(s)$ is the ideal price index for product s. Specifically, consumers' utility maximization yields $R_s = \left[P(s)^{\frac{-\nu}{1-\nu}} / \int_0^1 P(k)^{\frac{-\nu}{1-\nu}} dk\right] R$, where R is the total expenditure of the economy; $P(s) = \left[\int_{\omega\in\Omega_s} p(s,\omega)^{1-\sigma} d\omega\right]^{\frac{1}{1-\sigma}}$. Expressing R_s in terms of $P(s)$, R, and $\widehat{P}=\int_0^1 P(k)^{\frac{-\nu}{1-\nu}}\,dk$ in (A-1) gives the following expression.[40]

$$\lambda_s^*(\varphi)=\frac{\varsigma P(s)^{-\gamma}}{\varphi}\left(\frac{r^{\sigma\beta(s)}f_s\widehat{P}}{R}\right)^{\frac{1}{\sigma-1}},$$

where $\varsigma=\frac{\sigma^{\frac{1}{\sigma-1}}}{\rho}$ and $\gamma=\frac{\sigma(1-\nu)-1}{(\sigma-1)(1-\nu)}$. $\gamma>0$ if $\sigma>(1-\nu)^{-1}$.

Given φ and with $\lambda_s^*(\varphi)$ solved for the marginal product, firm expected profit from serving a given market is:

$$\pi(\varphi)=\int_0^1\left[\int_{\lambda_s^*(\varphi)}^{\overline{\lambda}}\pi_s(\varphi,\lambda_s)\,g(\lambda_s)\,d\lambda_s\right]ds-f_e$$

where $g(\lambda_s)$ is the stationary distribution for product attributes, which is discussed in detail in Bernard, Redding, and Schott (2010, 2011) (BRS hereafter). f_e is measured in labor, the only factor of production in BRS, but is measured in Home's consumption bundle here.

Similarly, we can use the zero-profit condition for export sales of product s to country j to solve for the consumer taste cutoff for foreign sales as

$$\lambda_{sj}^*(\varphi)=\frac{\varsigma\tau_j P_j(s)^{-\gamma}}{\varphi}\left(\frac{r^{\sigma\beta(s)}f_{sj}\widehat{P}_j}{R_j}\right)^{\frac{1}{\sigma-1}}.$$

Dividing $\lambda_{sj}^*(\varphi)$ by $\lambda_s^*(\varphi)$ gives the ratio in (5).

A.2.2 Price Indices

Next, we show that $\frac{P_j(s)}{P(s)}$ is decreasing in s if j is more capital-abundant than China (i.e., $\frac{w_j}{r_j}>\frac{1}{r}$). The price indices for a given product (suppressed product index s for simplicity) in China (c) and in country j, respectively are

$$\begin{aligned}
P_j &= \left[\int_{\omega\in\Omega_j}\left(\frac{p_j(\omega)}{\lambda(\omega)}\right)^{1-\sigma}d\omega+\int_{\omega\in\Omega_{cj}}\left(\frac{\tau_{cj}p_c(\omega)}{\lambda(\omega)}\right)^{1-\sigma}d\omega\right]^{\frac{1}{1-\sigma}};\\
P_c &= \left[\int_{\omega\in\Omega_c}\left(\frac{p_c(\omega)}{\lambda(\omega)}\right)^{1-\sigma}d\omega+\int_{\omega\in\Omega_{jc}}\left(\frac{\tau_{jc}p_j(\omega)}{\lambda(\omega)}\right)^{1-\sigma}d\omega\right]^{\frac{1}{1-\sigma}},
\end{aligned}$$

where Ω_k represents the set of products sold by firms in the domestic market k, and Ω_{kl} stands for the set of products exported by domestic firms in country k to country l. $\tau_{kl}>1$ is the iceberg trade cost for exporting from country k to country l.

[40] $R_s(\varphi,\lambda_s^*(\varphi))=\frac{P(s)^{\gamma(\sigma-1)}R}{\sigma\widehat{P}}\left(r^{-\beta(s)}\rho\varphi\lambda_s^*(\varphi)\right)^{\sigma-1}$.

Following the procedures in Bernard et al. (2007), the two price indices can be expressed as

$$P_j = \left[M_j\left(\frac{w_j^{1-\beta}r_j^{\beta}}{\rho\widetilde{\varphi}_j}\right)^{1-\sigma} + M_{cj}\left(\frac{\tau_{cj}r^{\beta}}{\rho\widetilde{\varphi}_{cj}}\right)^{1-\sigma}\right]^{\frac{1}{1-\sigma}};$$

$$P_c = \left[M_c\left(\frac{r^{\beta}}{\rho\widetilde{\varphi}_c}\right)^{1-\sigma} + M_{jc}\left(\frac{\tau_{jc}w_j^{1-\beta}r_j^{\beta}}{\rho\widetilde{\varphi}_{jc}}\right)^{1-\sigma}\right]^{\frac{1}{1-\sigma}},$$

where $\widetilde{\varphi}_k$ represents the weighted average productivity of firms selling in the domestic market k, weighted by the product attributes λ (see BRS (2011) for details); while $\widetilde{\varphi}_{kl}$ represents the weighted average productivity of firms in country k that export to country l. M_k and M_{kl} are the mass of firms selling in own market k or exporting from country k to country l, respectively. The total mass of entrants in each country can be solved by the free entry condition. Given the mass of entrants, M's can be solved in general equilibrium in terms of the underlying parameters and φ_c^*, φ_{cj}^*, $\lambda^*(\varphi_c^*)$ for the exporting country (c). To focus on providing theoretical guidelines for the empirical analysis, we refer the readers to BRS (2010, 2011) for details and take $M's$ as given here.

Without solving the model fully, we do know that since the fixed cost for exporting is higher than that for domestic sales, $M_c > M_{cj}$, $M_j > M_{jc}$, $\widetilde{\varphi}_{cj} > \widetilde{\varphi}_c$, and $\widetilde{\varphi}_{jc} > \widetilde{\varphi}_j$. Let us also assume that M_j/M_c, M_{jc}/M_{cj}, and $\widetilde{\varphi}_c/\widetilde{\varphi}_j$ are all increasing in β. We will come back to verify the validity of these assumptions later.

$$\left(\frac{P_j}{P_c}\right)^{\sigma-1} = \frac{\frac{M_c}{M_j} + \frac{M_{jc}}{M_j}\left(\frac{\widetilde{\varphi}_{jc}}{\widetilde{\varphi}_c}\frac{1}{\tau_{jc}w_j}\left(\frac{w_j r}{r_j}\right)^{\beta}\right)^{\sigma-1}}{\left(\frac{\widetilde{\varphi}_j}{\widetilde{\varphi}_c}\frac{1}{w_j}\left(\frac{w_j r}{r_j}\right)^{\beta}\right)^{\sigma-1} + \frac{M_{cj}}{M_j}\left(\frac{\widetilde{\varphi}_{cj}}{\tau_{cj}\widetilde{\varphi}_c}\right)^{\sigma-1}}.$$

Since $\frac{w_j}{r_j} > \frac{w}{r} \Longrightarrow \frac{w_j r}{r_j} > 1$. With the assumptions on M's and $\widetilde{\varphi}'s$ we made, it can be readily shown that $\left(\frac{P_j}{P_c}\right)^{\sigma-1}$ is decreasing in β (capital intensity). Thus, given a relatively "tougher market" for capital-intensive sectors in j, and given the mass of firms M, we can then show that $M_j/M_c, M_{jc}/M_{cj}$, and $\widetilde{\varphi}_c/\widetilde{\varphi}_j$ are all increasing in β, confirming our initial assumptions.

A.2.3 Discussion of Proposition 1

We now discuss briefly the argument that Proposition 1 holds as long as $\exists\overline{s}(\varphi) \in (0,1]$ such that $\lambda_{sj}^*(\varphi) \leq \lambda_s^*(\varphi)\,\forall s \leq \overline{s}(\varphi)$ and $\lambda_{sj}^*(\varphi) > \lambda_s^*(\varphi)\,\forall s > \overline{s}(\varphi)$. That is, for some products, there always exist customer taste cutoffs for exporting that are higher than those for domestic sales. Consider a firm that receives a favorable productivity shock (i.e., $\varphi_t > \varphi_{t-1}$) that triggers exporting to country j. Consider a given set of "consumer tastes", $\lambda's$. For $s \leq \overline{s}(\varphi)$, the probability that the firm exports product s to country j, conditional on positive domestic sales of product s is equal to $\Pi_1 = 1$. For $s \leq \overline{s}(\varphi)$, the probability of positive export sales conditional on no domestic sales is $\Pi_2 = \frac{1-G\left(\lambda_{sj}^*(\varphi)\right)}{G(\lambda_s^*(\varphi))}$. For $s > \overline{s}(\varphi)$, the probability of positive export sales conditional on positive domestic sales (the standard consideration) is $\Pi_3 = \frac{1-G\left(\lambda_{sj}^*(\varphi)\right)}{1-G(\lambda_s^*(\varphi))}$; and the probability of positive export sales conditional on no domestic sales is $\Pi_4 = 0$. Π_2 is increasing in s while Π_3 is decreasing in s if and only if $\lambda_{sj}^*(\varphi)/\lambda_s^*(\varphi)$ is increasing in s. Considering all four situations together, a new exporter is more likely to add products if $s \leq \overline{s}(\varphi)$; but less likely to export products with

$s > \bar{s}(\varphi)$, less so for higher s. This mechanism delivers $\Theta_d(\varphi) > \Theta_j(\varphi)$. In sum, Proposition 1 still holds even $\lambda^*_{sj}(\varphi) \leq \lambda^*_s(\varphi)\ \forall s \leq \bar{s}(\varphi) \in (0,1]$.

A.2.4 Proof of Corollary 1

The expression for the capital intensity of the firm after exporting (eq. (6)) can be rewritten as follows:

$$\Theta_{d+j}(\varphi) = \int_0^1 \left\{ \theta_s \int_{\lambda^*_s(\varphi)}^{\Phi_j(s)\lambda^*_s(\varphi)} \widehat{R}_s(\varphi,\lambda_s)\, g(\lambda_s)\, d\lambda_s + \int_{\Phi_j(s)\lambda^*_s(\varphi)}^{\infty} \left[\widehat{R}_s(\varphi,\lambda_s) + \widehat{R}_{sj}(\varphi,\lambda_s)\right] g(\lambda_s)\, d\lambda_s \right\} ds, \tag{A-2}$$

where $\widehat{R}_s(\varphi,\lambda_s) \equiv \frac{R_s(\varphi,\lambda_s)}{R(\varphi)+R_j(\varphi)}$ and $\widehat{R}_{sj}(\varphi,\lambda_s) \equiv \frac{R_{sj}(\varphi,\lambda_s)}{R(\varphi)+R_j(\varphi)}$. Notice that for products that have $\lambda_s \in [\lambda^*_s(\varphi), \Phi_j(s)\lambda^*_s(\varphi))$, the firm only sells the product in the domestic market, making revenue equal to $R_s(\varphi,\lambda_s)$ as before. Their shares in the firm's total sales will drop (i.e., $\frac{R_s(\varphi,\lambda_s)}{R(\varphi)+R_j(\varphi)} < \frac{R_s(\varphi,\lambda_s)}{R(\varphi)}$). For products that have $\lambda^*_s(\varphi) > \Phi_j(s)\lambda^*_s(\varphi)$, the change in the share of each individual product is ambiguous. However, since products with $\lambda^*_s(\varphi) < \Phi_j(s)\lambda^*_s(\varphi)$ all have lower shares in the firm's total sales, at least some products with $\lambda^*_s(\varphi) > \Phi_j(s)\lambda^*_s(\varphi)$ must experience an increase in their share in the firm's total sales, contributing a larger weight in affecting the firm's capital intensity. Since $\frac{\partial \Phi_j(s)}{\partial s} > 0$, the probability that the product will have a larger weight is decreasing in s. In other words, labor-intensive products are more likely to have a larger weight in the firm's product portfolio. By the law of large number, the firm's capital intensity will be lower after exporting to a country that is more capital-abundant than China.

Now consider another firm that has the same φ. By the law of large number, its ex ante average capital intensity across products is the same, yielding the same ex ante firm capital intensity. Suppose it also starts exporting but to country k, which is less capital-abundant than j but more capital abundant than China. For simplicity, suppose all costs for exporting to k are the same as those for exporting to j ($\tau_j = \tau_k$, $f_{sj} = f_{sk}$), and that both destination countries have the same real incomes, $\frac{\Phi_k(s)}{\Phi_j(s)}$ can be expressed as follows:[41]

$$\frac{\Phi_k(s)}{\Phi_j(s)} = \left(\frac{P_j(s)}{P_k(s)}\right)^{\gamma}.$$

Given that k is more capital-abundant than j, $\frac{P_j(s)}{P_k(s)}$ and thus $\frac{\Phi_k(s)}{\Phi_j(s)}$ are increasing in s.[42] In words, if the destination country is more capital-abundant, the product cutoff for exporting is rising faster in s. Thus, destination countries' capital endowment will be associated with different product composition and thus firm capital intensity. If $\Phi_k(s)/\Phi_j(s)$ is increasing in s and $\Phi_k(s) > \Phi_j(s)$ for $s > \widehat{s} \in (0,1)$, according to eq. (A-2), by the law of large number, exporting to a more capital-abundant country is associated with larger shares of labor-intensive products in the firm's product portfolio. Thus, $\Theta_{d+k}(\varphi) < \Theta_{d+j}(\varphi)$ even though the two firms have the same ex ante capital intensity.

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[41] Generically, $\frac{\Phi_k(s)}{\Phi_k(s)} = \frac{\tau_k}{\tau_j}\left(\frac{f_{sk}}{f_{sj}}\frac{R_j/\widehat{P}_j}{R_k/\widehat{P}_k}\right)^{\frac{1}{\sigma-1}}\left(\frac{P_j(s)}{P_k(s)}\right)^{\gamma}$.

[42] For our assumption of identical price indices across countries (i.e., $\widehat{P}_j = \widehat{P}_k$) to hold and $\frac{\partial \frac{P_j(s)}{P_k(s)}}{\partial s} > 0$, there must exist $\widehat{s} \in (0,1)$ so that $P_j(s) < P_k(s)$ for $s \in (0,\widehat{s})$ and $P_j(s) \geq P_k(s)$ for $s \in [\widehat{s},1)$.

A.3 Procedures to compute the measures of capital intensity at the HS 6-digit level

A.3.1 Using the pooled sample

1. For each year, calculate the capital intensity of each firm in the National Bureau of Statistics (NBS) firm data.

2. Merge NBS data with customs data using firm names, addresses, and other firm identifiers. See Appendix Table A6 for detailed information about the merging.

3. For each year and each HS6 product, calculate the weighted average of the capital intensity of all firms exporting that product, with weights equal to firm export value. This is our preferred measure of product capital intensity. Alternatively, we calculate the median capital intensity of all firms exporting the same HS6 product.

A.3.2 For each new exporter

1. For each new exporters in 2001 (who didn't export in 2000, the first year of the customs trade data), find continuing products and newly added products in 2002.

2. For each new exporter in 2001, calculate the weighted average capital intensity of new products and continuing products in 2002, with weights equal to firm export shares in 2002. We also calculate the weighted average capital intensity of dropped products in 2001, with weights equal to firm export shares in 2001.

3. Repeat the Steps 1-2 for 2002 all the way to 2005.