Firm dynamics and trade: Appendix*

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*This appendix and the associated data and code files are available at kimjruhl.com.

A Export-investment model details

The general model follows Alessandria et al. (2013a). Looking ahead to the calibration, we will allow for three values of ξ, the export variable cost: $\xi_\infty > \xi_H > \xi_L$, where $\xi_\infty = \infty$. The Markov transition probability is $\rho_\xi(\xi'|\xi)$. The firm's productivity, z, also follows a Markov process with transition probability $\phi(z'|z)$. We lay out the home-country decision problems and variables. The foreign-country problems and variables are analogous.

A.1 Production

The **intermediate-good** firm's problem is the same as that laid out in Section 3, except for a generalized production function. The firm's production function is

$$y_i = \left(z k_i^{\alpha} \ell_i^{1-\alpha}\right)^{1-\alpha_x} x^{\alpha_x}, \tag{A.1}$$

where x is the use of intermediate goods and k is physical capital. Let the firm's state variables be denoted $s = (z, \xi, f)$.

New intermediate-good firms are created by hiring f_e units of labor and draw their initial productivity levels from a distribution ϕ_e. The free-entry condition is

$$w_t f_e \leq \frac{1}{1 + r_{t+1}} \int V_{t+1}(z_{t+1}, \xi_\infty, f_0) \phi_e(z_{t+1})\, dz_{t+1}. \tag{A.2}$$

New firms are created until the expected value of a new firm is equal to the cost of creating one. The free-entry condition is written assuming a one-period lag between firm creation and operation, and that new firms are nonexporters who face f_0. The mass of firms created is N_{et} and the mass of incumbent firms is N_t.

The intermediate goods produced by the firms are aggregated into a **final good**. The final-good market is perfectly competitive and the production function is characterized by constant returns to scale,

$$D_t^{\frac{\theta-1}{\theta}} = \int y_{Ht}(s)^{\frac{\theta-1}{\theta}} \mu_t(s)\, ds + \int y_{Ft}(s)^{\frac{\theta-1}{\theta}} \mu_t^*(s)\, ds, \tag{A.3}$$

where $y_{jt}(s)$ are purchases from country j by the home country. The distributions of firms in the home and foreign countries are $\mu(s)$ and $\mu^*(s)$. The representative firm solves

$$\max_{y_{Ht}(s), y_{Ft}(s)} D_t - \int p_{Ht}(s) y_{Ht}(s) \mu_t(s)\, ds + \int \tau \xi(s) p^*_{Ft}(s) y_{Ft}(s) \mu^*_t(s)\, ds, \tag{A.4}$$

where $p_{Ht}(s)$ is the price paid in the home country for a good produced domestically. $p^*_{Ft}(s)$ is the price the foreign producer charges in the foreign market. The price paid in the home country is $p_{Ft}(s) = \tau\xi(s) p^*_{Ft}(s)$. With the normalization that P, the final good price, is one, the solution to this problem is the well-known CES demand function in (5).

A.2 Households

Households inelastically supply labor, invest in physical capital, and consume. The representative household's problem is

$$\max_{C_t, K_{t+1}} \mathbb{E} \sum_{t=0}^{\infty} \beta^t \frac{C_t^{1-\sigma}}{1-\sigma}$$

$$\textbf{s.t.}\ \ C_t + K_{t+1} = w_t L_t + (1 + r_t - \delta_k) K_t + T_t + \Pi_t \qquad t = 0, 1, \ldots \tag{A.5}$$

$$C_t > 0,\ \ K_0 = \overline{K} \tag{A.6}$$

where L is the household's labor endowment, r is the rental rate of capital, w is the wage, T is the lump-sum rebate of tariff revenue, and Π is the profit earned by domestic firms. The household's problem determines the path of expenditures and the interest rate. The intertemporal elasticity of substitution and the wealth effect on labor supply are important determinants of the aggregate effects of a shock.

Implicit in the budget constraint is an assumption that the household cannot borrow or lend internationally. In our experiments, we study symmetric policies and symmetric countries, so this is not an important assumption. Recent work, however, emphasizes that the response to a change in trade barriers depends on the financial assets available for trade.[1]

[1] See, for example, Alessandria et al. (2013a); Reyes-Heroles (2015); Alessandria and Choi (2016); Eaton et al. (2016); Alessandria et al. (2017); Ravikumar et al. (2019).

A.3 Market clearing, aggregate variables, and laws of motion

The market clearing condition for labor is

$$L_t = L_{pt} + L_{et} + L_{xt} \tag{A.7}$$

where L_p is total labor used to produce goods, L_x is total labor used to pay export fixed costs, and L_e is total labor used to create new firms.

Final-goods market clearing is

$$D_t = C_t + K_{t+1} - (1-\delta_k)K_t + X_t, \tag{A.8}$$

where total intermediate good usage is

$$X_t = \int x_t(s)\,\mu_t(s) \tag{A.9}$$

and capital market clearing is

$$K_t = \int k_t(s)\,\mu_t(s). \tag{A.10}$$

The government rebates tariff revenue to the household. The household owns the intermediate-good firms and receives their profits. Aggregate tariff revenue and firm profits are

$$T_t = (\tau - 1) \sum_{m \in \{L,H\}} \int p_{Ft}\left(z, \xi_m, f_1\right) y_{Ft}\left(z, \xi_m, f_1\right) \mu_t^*\left(z, \xi_m, f_1\right) dz, \tag{A.11}$$

$$\Pi_t = \sum_{\substack{m \in \{L,H,\infty\} \\ f \in \{f_0, f_1\}}} \int \pi_t(z, \xi_m, f) \mu_t\left(z, \xi_m, f\right) dz - w_t L_{x,t} - w_t f_e N_{e,t}. \tag{A.12}$$

The laws-of-motion for the distribution of firms depend on the entry and exit thresholds (z_m) the exogenous continuation rate of firms (δ), the creation of new firms (N_e) and the transition probabilities for z and ξ,

$$\mu_{t+1}\left(z',\xi_{\infty},f_0\right) = \sum_{\substack{m\in\{L,H,\infty\}\\ f\in\{f_0,f_1\}}} \int_{-\infty}^{z_{m,t}} \delta\left(z\right)\mu_t\left(z,\xi_m,f\right)\phi\left(z'|z\right)dz + N_{e,t}\,\phi_e\left(z'\right), \tag{A.13}$$

$$\mu_{t+1}\left(z',\xi_H,f_1\right) = \sum_{\substack{m\in\{L,H,\infty\}\\ f\in\{f_0,f_1\}}} \rho_\xi\left(\xi_H|\xi_m\right) \int_{z_{m,t}}^{\infty} \delta\left(z\right)\mu_t\left(z,\xi_m,f\right)\phi\left(z'|z\right)dz, \tag{A.14}$$

$$\mu_{t+1}\left(z',\xi_L,f_1\right) = \sum_{\substack{m\in\{L,H,\infty\}\\ f\in\{f_0,f_1\}}} \rho_\xi\left(\xi_L|\xi_m\right) \int_{z_{m,t}}^{\infty} \delta\left(z\right)\mu_t\left(z,\xi_m,f\right)\phi\left(z'|z\right)dz. \tag{A.15}$$

B Export-inventory model details

The export-inventory model closely follows Alessandria et al. (2010a), except we eliminate physical capital and we focus on the effects of a tariff reduction. Compared to the export-investment model, this model has a simpler firm structure. There is a continuum of intermediate goods (indexed by $j \in [0,1]$) produced in Home, and a continuum of intermediate goods produced in Foreign. Only a fraction, n_x, of these goods are exported. The mass of firms and mass of exporters are constant. We lay out the home-country decision problems and variables. The foreign-country problems and variables are analogous.

B.1 Production

Final-good producers combine intermediate goods to form the final good. We denote goods produced in Home with a subscript H and goods produced in Foreign with a subscript F. The final-good market is perfectly competitive and the production function is characterized by constant returns to scale,

$$D_t^{\frac{\theta-1}{\theta}} = \int_0^1 \xi_{Ht}^{\frac{1}{\theta}}\left(j\right) y_{Ht}(j)^{\frac{\theta-1}{\theta}}dj + \int_0^{n_x} \xi_{Ft}\left(j\right)^{\frac{1}{\theta}} y_{Ft}(j)^{\frac{\theta-1}{\theta}}dj, \tag{A.16}$$

where the weights $\xi_H\left(j\right)$ and $\xi_F\left(j\right)$ are subject to shocks that are iid across j and t. The idiosyncratic shocks generate heterogeneity in demand and introduce a precautionary motive for inventories. The representative firm solves a maximization problem analogous to the one in (A.4)

Intermediate-good firms have identical production functions that require only labor

$$y_t = \ell_t. \tag{A.17}$$

Production takes place only in the firm's country of origin. The firm holds inventory in its country of origin to sell to its domestic final-goods producers. The subset of exporting firms hold inventory abroad for sale to the foreign final-goods producers.

The firm's problem is separable across markets. In each period and location, a firm begins with a stock of goods, z, and a realization of its demand shock, ξ. It must decide how much to sell and whether to replenish its inventories. If the firm makes a shipment, it pays a fixed cost of f_d if shipping to the domestic location or f_x if shipping to the foreign location. If the firm sends a shipment, it arrives within the current period with probability γ_i, $i \in \{d, x\}$, and is available for sale immediately. With probability $1 - \gamma_i$ the shipment arrives in the next period. In addition to the fixed shipping cost, shipments abroad are subject to a tariff of $\tau_x \geq 1$ with the normalization that $\tau_d = 1$.

The firm chooses the shipment size, x, and how much to sell out of inventories, y. If the firm chooses $x = 0$ it avoids the fixed shipping costs. The value of a home firm serving location i is

$$V_{it}(z, \xi) = \max_{0 \leq x} \left\{ V_{it}^0(z, \xi), -f_i - \tau_i x + \gamma_i V_{it}^0(z + x, \xi) + (1 - \gamma_i) V_{it}^1(z, \xi, x) \right\}. \tag{A.18}$$

The first term in the maximization is the value of not making a shipment. The second term is the value of making a shipment. It requires the payment of fixed costs and the tariff. The value of serving the market, having received a shipment in the period, is

$$V_{it}^0(z, \xi) = \max_{0 \leq y \leq z} p(y; \xi)\, y + \frac{1}{1 + r_t} \mathop{\mathbb{E}}_{\xi'} V_{it+1}\left((1 - \delta)(z - y), \xi'\right), \tag{A.19}$$

where $p(y; \xi)$ is the residual demand function from (A.4). Note that held-over inventories,

$z-y$, depreciate at rate δ. This assumption captures the costs associated with inventory storage. If the shipment does not arrives in the current period, the value of the firm is

$$V_{it}^{1}(z,\xi,x)=\max_{0\leq y\leq z} p(y;\xi)\,y+\frac{1}{1+r_t}\mathop{\mathbb{E}}_{\xi'} V_{it+1}\left((1-\delta)(z-y+x),\xi'\right). \tag{A.20}$$

Notice that, unlike the export-investment model, there are no persistent differences in a firm's exogenous state variable (ξ) but these temporary shocks generate persistent differences through the inventory investment decision.

B.2 Households

The household's problem is the same as the one in Section A.2, except the household in this model does not make an investment in physical capital.

B.3 Market clearing, aggregate variables, and laws of motion

Let $\mu_i(z)$ denote the mass of firms with beginning of period inventories of z. Then the distribution over inventories and demand shocks is $\mu_i(z,\xi)=\mu_i(z)\,f(\xi)$, where $f(\xi)$ is the probability density function of ξ. Given the decision rules, let $0\leq I(z',z,\xi)\leq 1$ denote the fraction of firms that start with (z,ξ) and end with z'. For firms that do not place an order, this is equal to either zero or one. For firms that place an order, this is between zero and one owing to the heterogeneity in shipment arrival. The law of motion for the distribution of firms over inventories and demand shocks is

$$\mu(z',\xi')=f(\xi')\int\!\!\int I(z',z,\xi)\,\mu_i(z,\xi)\,d\xi\,dz. \tag{A.21}$$

Fixed shipment costs are paid in units of domestic labor. The market-clearing condition for labor is

$$L_t=L_{pt}+L_{xt}, \tag{A.22}$$

where L_{pt} is labor used in production and L_{xt} is labor used for shipping costs. Final-goods market clearing is

$$D_t = C_t. \tag{A.23}$$

Aggregate tariff revenue and firm profits are

$$T_t = (\tau - 1) \iint p_{Ft}(z,\xi)\, y_{Ft}(z,\xi)\, \mu_t^*(z,\xi)\, dz\, d\xi \tag{A.24}$$

$$\Pi_t = \iint \pi_t(z,\xi)\mu_t(z,\xi)\, dz\, d\xi - w_t L_x. \tag{A.25}$$

C Calibration details

Our aim is to show how trade frictions influence both firm-level dynamics and the aggregate effects of a change in trade policy. To highlight the role of these trade frictions, we compare models with rich trade frictions (the export-investment and export-inventory models) to those without (the no-cost models). To facilitate comparisons, we calibrate the models to be as similar as possible, while also recognizing that they are geared to explain different economic behaviour at different horizons.

C.1 The export-investment model

The calibration of the benchmark (*new-exporter*) model is taken from Alessandria et al. (2013a), which considers the United States in the early 1990s.[2] We assume a tariff rate of ten percent ($\tau = 1.1$). We provide an overview of the calibration here and the details can be found in Alessandria et al. (2013a).

The first set of parameters are found in many aggregate models and their values are set to standard values. The intertemporal elasticity of substitution is set to one ($\sigma = 2$) and $\beta = 0.96$ generates a four-percent annual interest rate. The elasticity of substitution in final good production (θ) is set to five. The depreciation rate of physical capital (δ_k) is 0.1. The share of intermediate goods in production of differentiated goods ($\alpha_x = 0.804$) governs the ratio of gross output to value added.

[2] One difference from that paper is that, here, we set the capital share in production to $\alpha = 0.3$ rather than match the labor share of income. We do this to ease comparison across models.

The second set of common parameters govern a firm's productivity life cycle, but are not export-specific. The firm productivity process follows an AR1 process

$$z' = \rho_z z + \epsilon_z \qquad \epsilon_z \sim \mathrm{N}(0, \sigma_z), \tag{A.26}$$

which will be converted to a discrete Markov process for computation. In the data, newly-created firms are smaller than incumbents. To capture this relationship, the productivity of a newly-created firm is $z = \mu_e + \epsilon_e$ where ϵ_e is drawn from the unconditional distribution over z. With $\mu_e < 0$, new firms are less productive and smaller than incumbents. We model exogenous firm destruction as a function of productivity, $1-\delta(z) = \max\{0, \min\{e^{\chi_0 z}+\chi_1, 1\}\}$. The parameters (χ_0, χ_1) imply that the probability of a firm exiting production is decreasing in z.

The remaining parameters govern the cost structure of exporting and creating a new firm. The cost of creating a new firm, f_e, is set to normalize the mass of firms in the steady state to one. The process over variable trade costs is

$$\xi' = \rho_\xi \xi + \epsilon_\xi \qquad \epsilon_\xi \sim \mathrm{N}(0, \sigma_\xi). \tag{A.27}$$

To keep things simple, we discretize the process over variable trade costs into two values. The trade cost can be either high or low, with $\xi_L \leq \xi_H$. With probability ρ_ξ, the firm's ξ stays constant and with probability $1 - \rho_\xi$ it switches.

These ten parameters $\{\chi_0, \chi_1, \rho_z, \sigma_z, \mu_e, f_0, f_1, \xi_L, \xi_H, \rho_\xi\}$ are chosen to match 18 moments. One set of moments describes exporting behavior: the mean export intensity; the initial export intensity of a new exporter; the five-year growth in a new exporter's export intensity; the export stopper rate; and the export participation rate. The other set of moments describe firm creation and destruction: the five-year exit rate for new firms; the aggregate share of labor accounted for by new firms and closing firms; and the establishment-size distribution (as measured by employment) discretized into ten points. The calibration is summarized in Table A.1.

The no-cost model

The no-cost model has $f_0 = f_1 = 0$, and $\xi_H = \xi_L$ is chosen so that the aggregate export-sales ratio is 8.1 percent as it is in the export-investment model. All other parameters remain the same.

We also consider a variation of the no-cost model with a higher Armington elasticity and an adjustment cost on the domestic expenditure share. This is the *static adjustment costs* model in Table 8 and Figure 3. Specifically, we introduce a time-varying weight on imported goods, g_t, into the aggregator,

$$D_t^{\frac{\theta_A-1}{\theta_A}} = \left[\int_z y_{h,t}^d(z)^{\frac{\theta-1}{\theta}} \varphi_t(z)\, dz\right]^{\frac{\theta}{\theta-1}\frac{\theta_A-1}{\theta_A}} + g_t \left[\int_z y_{f,t}^d(z)^{\frac{\theta-1}{\theta}} \varphi_t^*(z)\, dz\right]^{\frac{\theta}{\theta-1}\frac{\theta_A-1}{\theta_A}}, \tag{A.28}$$

$$g_t = g_{t-1}^{\rho_g}\left[\left(\frac{\lambda_t}{\lambda_{t-1}}\right)^{\upsilon}\right]^{1-\rho_g}, \quad g_{-1} = 1, \tag{A.29}$$

where λ_t is the aggregate domestic intermediate-goods' expenditure share. With $\upsilon > 0$, an increase in the import share lowers the weight on imports in the aggregator. This demand shifter is external to the final-goods producer. It affects only the transition and not the steady state. The parameters of the final goods aggregator, υ and ρ_g, are set to minimize the sum of squared differences between the paths of the trade elasticity in the benchmark model and this variation of the no-cost model.

C.2 The export-inventory model

The inventory model is calibrated to be as similar to the exporting model as possible, while including moments related to inventories and shipment lumpiness that help identify trade frictions $\{f_i, \gamma_i, \sigma_\xi\}$. We assume 22 percent of firms can export ($n_x = 0.22$) and we target a total export-sales ratio of 8.1 percent. The period is one-quarter, so the discount factor is $\beta = 0.99$. The depreciation rate on inventories is $\delta = 0.075$. The tariff is ten percent and the variable shipping cost is 15 percent. We follow Alessandria et al. (2010b) in setting the variance of idiosyncratic shocks (σ_ξ).

The fixed costs (f_i) and probabilities that goods arrive in the current period (γ_i) are set to yield an aggregate inventory-sales ratio of 1.06; an inventory-sales ratio on imports that is three times that on domestic goods; import orders that are half as frequent as domestic orders; and an international delivery lag of one quarter.

We find that domestic orders, on average, take six weeks ($\gamma_d = 0.475$) compared to one quarter for imports ($\gamma_x = 0$). International ordering costs ($f_x = 0.63$) are almost six times larger than domestic ordering costs ($f_d = 0.10$). The domestic fixed cost is 2.7 percent of mean firm revenue, although they are not incurred every period.

The no-cost model

The static no-cost model eliminates the delivery lag ($\gamma_d = \gamma_x = 1$) and goods depreciate fully between periods ($\delta = 1$). This is a version of the Melitz (2003) model with idiosyncratic demand shocks. To highlight the role of trade frictions in the short-run propagation of shocks, the Armington elasticity is set so that the no-cost and the export-inventory models have the same long-run trade elasticity.

D Model extensions

We consider several extensions of the benchmark export-investment model that have been proposed to explain features of the data on exporter characteristics and dynamics. To abstract from the role of new exporter dynamics, in each of these extensions, we keep the iceberg costs constant over time. To facilitate comparison across models, we calibrate the fixed costs and iceberg costs to match the export sales ratio, export-participation rate, stopper rate, and average export-intensity. Not all models have enough parameters to match all the moments. The calibrations are summarized in Table A.1.

The sunk-cost model. f_0, f_1, and $\xi_H = \xi_L$ are chosen to match the export sales ratio, the export-participation rate, and the stopper rate. The untargeted exporter intensity and exporter premium are close to their values in the new-exporter model.

The search model. We extend the sunk-cost model by assuming that paying the entry cost only leads to a reduction in iceberg shipping costs with probability η. We choose f_0, f_1, $\xi_H = \xi_L$, and η to match the same four moments we match in the new-exporter model.

The reentry model. We introduce a reentry cost, $f_R < f_0$, to the sunk-cost model. A firm pays f_R to enter the export market if it has paid f_0 in the past. We choose f_0, f_1, f_R, and $\xi_H = \xi_L$ to match the same four moments we match in the new-exporter model.

The calibrated parameter values provide insight into the mechanisms at work in the models. Creating a new firm is most expensive in the no-cost model. In this model, creating a new firm also creates an exporter: Exporting is bundled with firm creation. The other models unbundle these decisions in different ways and f_e falls. In all of the models, the export entry cost is small relative to the firm creation cost as export profits are relatively low in these economies. Moving from the sunk-cost model to the new exporter model decreases f_0/f_e by 65 percent. This is the result of slowing down the export-intensity growth of new exporters. The entry cost is largest in the reentry model. Paying the entry cost in this model yields a long-lived option to reenter the market at a lower cost. This more-valuable investment comes at a higher price. The search model has a low export entry cost. With probability 0.87, the entrant fails and the investment is worthless. This less-valuable investment comes at a lower price. The re-entry cost is about half of the entry cost but about twice the continuation cost.

Trade liberalization in the extended models

The aggregate effects of a trade liberalization are quite similar across these three new variants but are quite different from the new-exporter model (Table A.1, top panel). All the dynamic models feature overshooting, so the change in steady-state consumption is smaller than the welfare gain. Unlike the new-exporter model, though, the ratio of the welfare gain to the steady-state change in consumption is near two. This suggests that focusing on the evolution of export sales conditional on staying in the market is the most important margin to understand.

Table A.1: Model outcomes and parameters

	No cost	Sunk	Search	Reentry	New exporter
Long-run elast.	4.00	7.19	7.35	7.29	11.55
ΔC_{ss}	5.07	2.79	2.70	2.74	0.75
Δ Welfare	3.91	5.92	6.19	6.04	7.78
Δ Welfare/ΔC_{ss}	0.77	2.12	2.30	2.21	10.44
Moments:					
Export-sales ratio	8.1	8.1	8.1	8.1	8.1
Participation rate	100.0	22.3	22.3	22.3	22.3
Exporter premium	1.0	2.8	2.7	2.7	2.7
Exporter intensity	8.1	13.1	13.3	13.3	13.3
Stopper rate	0	17.0	17.0	17.0	17.0
Parameters:					
f_e	7.95	0.936†	0.935†	0.934†	0.921†
f_0/f_e	0	0.058	0.051	0.067	0.038
f_1/f_0	–	0.263	0.49	0.241	0.715
ξ_H	1.63	1.42	1.42	1.42	1.72
ξ_L	1.63	1.42	1.42	1.42	1.07
ρ_ξ	1.0	1.0	1.0	1.0	0.92
η	1.0	1.0	0.87	1.0	1.0
f_R/f_0	–	1.0	1.0	0.49	1.0
Common parameters:	$\theta = 5$, $\beta = 0.96$, $\sigma = 1$ $\delta_k = 0.1$, $\alpha = 0.3$, α_x =0.804, $\tau = 1.1$				
	$\rho_z = 0.654$, $\sigma_z = 0.264$, $\mu_e = -0.269$, $\chi_0 = 21.04$, $\chi_1 = 2.23$				

†The firm-creation costs, f_e, for the sunk, new-exporter, search, and reentry models are expressed as fractions of the firm-creation cost in the no-cost model.

Table A.2: Summary of models of firm dynamics

Feature in the data	Feature in the model	Papers
Export status persistence, Exchange rate hysteresis	Sunk entry costs Structural estimation General equilibrium, aggregate shocks	Baldwin (1988), Baldwin and Krugman (1989), Roberts and Tybout (1997), Das et al. (2007), Alessandria and Choi (2007), Alessandria and Choi (2014)
New-exporter survival rates, Intensive margin growth	Demand a function of time in market Capital adjustment dynamics Customer accumulation	Ruhl and Willis (2017), Riaño (2011), Rho and Rodrigue (2016), Drozd and Nosal (2012), Fitzgerald et al. (2016), Piveteau (2016)
	Learning	Albornoz et al. (2012), Arkolakis et al. (2018)
	Financial frictions	Kohn et al. (2016), Brooks and Dovis (2019)
	Selection	Arkolakis (2016)
	Importing and Exporting	Kasahara and Lapham (2013)
	Search	Eaton et al. (2014), Lu et al. (2016)
Innovation and trade	Endogenous R&D	Aw et al. (2011)
Effects of future tariffs on current trade	Uncertainty and sunk costs	Pierce and Schott (2016), Handley and Limão (2017), Steinberg (2019)
	Inventories and anticipation effects	Khan and Khederlarian (2019), Alessandria et al. (2019)
Infrequent exporting	Per-shipment fixed costs, inventories	Alessandria et al. (2010a)
Short-run, long-run elasticities	Uncertainty and sunk cost	Ruhl (2008),
	Repeated investments in export technology	Alessandria et al. (2013b)
	Multi-country or multi-industry dynamic models	Imura (2019), Mix (2019)

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