

Proofs of the Five Propositions

Proposition 1: An autarky fair wage equilibrium exists and is unique.

Proposition 2: The fair wage equilibrium with trade in final and intermediate goods exists and is unique.

The proofs for the autarky and trade cases follow one another closely, so we will provide the proof for the only slightly more complicated trade case. Equilibrium is developed similar to Melitz (2003), involving two relations between average profits $\bar{\pi}$ and the marginal firm as indexed by its productivity $\hat{\varphi}^*$. The first of these relations is the Free Entry (FE) condition and the second is the Zero Cutoff Profit (ZCP).

We begin with the FE condition. From above, firms that pay the entry cost learn the triplet $\lambda_\nu \equiv (\varphi_\nu, t_{M\nu}, t_{X\nu})$. We have shown that for a notional cutoff $\hat{\varphi}^*$ we can write the profits of a firm ν , conditional on the cutoff, as $\pi(\lambda_\nu, \hat{\varphi}^*)$. In any notional equilibrium, surviving firms are the set $\{\nu \mid \varphi \geq \hat{\varphi}^*\}$ and so the share of surviving firms is $[1 - G_\Phi(\hat{\varphi}^*)]$.

The FE condition is standard and requires that *ex ante* expected profits equal zero. Letting $\bar{\pi}$ be expected per-period *ex post* profits and $\hat{\varphi}^*$ be the marginal physical productivity of the marginal firm, this can be written:

$$(A1) \quad \bar{\pi} = \frac{\delta f_e}{[1 - G_\Phi(\hat{\varphi}^*)]}$$

This is an increasing relation as a higher cutoff (lower expected survival probability) must be compensated by higher expected profits to justify the fixed entry costs.

Next we turn to the ZCP Condition. The notional cutoff $\hat{\varphi}^*$ determines profits according to firm type and the distribution of active firm types $\mu(\lambda_\nu, \hat{\varphi}^*) = \frac{g(\lambda_\nu)}{1 - G_\Phi(\hat{\varphi}^*)}$. Thus we can also calculate average profits conditional on this cutoff, $\bar{\pi}(\hat{\varphi}^*)$. The pair $(\bar{\pi}(\hat{\varphi}^*), \hat{\varphi}^*)$ determines one point on the ZCP curve. The entire ZCP curve is derived by repeating this for each potential cutoff productivity. Existence of equilibrium requires that the ZCP curve and the FE curve intersect.

The existence proof proceeds in two parts. Since FE rises continuously in $\hat{\varphi}^*$, it suffices to show the following two facts along the ZCP curve: (i) $\lim_{\hat{\varphi}^* \rightarrow \infty} \bar{\pi} = 0$; and (ii) $\lim_{\hat{\varphi}^* \rightarrow 0} \bar{\pi} = \infty$.

We consider these in turn. The profits of a firm can be written as $\pi_\nu = \pi(\lambda_\nu, \hat{\varphi}^*)$. Thus the average wage can be written as $\bar{\pi}_{ZCP} = \frac{1}{1 - G_\Phi(\hat{\varphi}^*)} \int_{\hat{\varphi}^*}^{\infty} \int_{t_M}^{\infty} \int_{t_X}^{\infty} \pi(\lambda_\nu, \hat{\varphi}^*) g(\lambda_\nu) dt_X dt_M d\varphi$.

We can also define an auxiliary profit function, given by $\tilde{\pi}_\nu = \tilde{\pi}(\lambda_\nu, \hat{\varphi}^*)$, where this is the profit that firm ν would have given its actual level of productivity if it had $W_\nu = 1$, as in Melitz. Note in particular that $\tilde{\pi}(\lambda_\nu, \hat{\varphi}^*) \geq \pi(\lambda_\nu, \hat{\varphi}^*)$. Hence also, the average profits associated with the auxiliary function are higher:

$$\begin{aligned} \bar{\tilde{\pi}}(\hat{\varphi}^*) &= \frac{1}{1 - G_\Phi(\hat{\varphi}^*)} \int_{\hat{\varphi}^*}^{\infty} \int_{t_M}^{\infty} \int_{t_X}^{\infty} \tilde{\pi}(\lambda_\nu, \hat{\varphi}^*) g(\lambda_\nu) dt_X dt_M d\varphi \\ &\geq \bar{\pi}(\hat{\varphi}^*) \end{aligned}$$

Since profits of all firms are non-negative, so must be the average $\bar{\pi}(\hat{\varphi}^*) \geq 0$. Hence, a sufficient condition for $\lim_{\hat{\varphi}^* \rightarrow \infty} \bar{\pi} = 0$ is that $\lim_{\hat{\varphi}^* \rightarrow \infty} \bar{\tilde{\pi}} = 0$.

Now we need to look directly at the auxiliary profits:

$$\tilde{\pi}_\nu(\lambda_\nu; \hat{\varphi}^*) = \text{Max} \begin{cases} 0 & \text{exit} \\ \hat{\varphi}^{*1-\sigma} f \left(\frac{1}{\varphi_\nu} \right)^{1-\sigma} - f & \text{domestic only} \\ \Gamma_{M\nu} \hat{\varphi}^{*1-\sigma} f \left(\frac{1}{\varphi_\nu} \right)^{1-\sigma} - (f + nf_M) & \text{imported intermediates} \\ \Gamma_{X\nu} \hat{\varphi}^{*1-\sigma} f \left(\frac{1}{\varphi_\nu} \right)^{1-\sigma} - (f + nf_X) & \text{exported final goods} \\ \Gamma_{X\nu} \Gamma_{M\nu} \hat{\varphi}^{*1-\sigma} f \left(\frac{1}{\varphi_\nu} \right)^{1-\sigma} - [f + n(f_X + f_M)] & \text{imp'd interm's \& exp'd final gds} \end{cases}$$

As is evident, in the limit as $\hat{\varphi}^* \rightarrow \infty$, the profits of every firm in each mode of globalization are driven to zero, hence so also is the firm maximum as well as the average profits $\lim_{\hat{\varphi}^* \rightarrow \infty} \bar{\tilde{\pi}} = 0$. This was our sufficient condition to show that $\lim_{\hat{\varphi}^* \rightarrow \infty} \bar{\pi} = 0$, as required for the first part of our proof.

We now turn to the second part of the existence proof, which requires that $\lim_{\hat{\varphi}^* \rightarrow 0} \bar{\pi} = \infty$.

The proof proceeds by developing a new auxiliary function, denoted $\pi_\nu = \pi(\lambda_\nu, \bar{W}, \hat{\varphi}^*)$, which represents the maximized profits available to a firm with draw λ_ν , paying wages \bar{W} , when the cutoff is $\hat{\varphi}^*$.

Note that for every firm, $\pi(\lambda_\nu, \hat{\varphi}^*) \geq \pi_\nu(\lambda_\nu, \bar{W}, \hat{\varphi}^*)$, so that this is also true for the averages, $\bar{\pi}(\lambda_\nu, \hat{\varphi}^*) \geq \bar{\pi}_\nu(\lambda_\nu, \bar{W}, \hat{\varphi}^*)$. Thus a sufficient condition for $\lim_{\hat{\varphi}^* \rightarrow 0} \bar{\pi} = \infty$ is to show that

$\lim_{\hat{\varphi}^* \rightarrow 0} \bar{\pi}_\nu = \infty$. We look first at the profitability of an individual firm:

$$\tilde{\pi}_\nu(\lambda_\nu, \bar{W}, \varphi^*) = \text{Max} \begin{cases} 0 & \text{exit} \\ \varphi^{*1-\sigma} f \left(\frac{\bar{W}}{\varphi_\nu} \right)^{1-\sigma} - f & \text{domestic only} \\ \Gamma_{M\nu} \varphi^{*1-\sigma} f \left(\frac{\bar{W}}{\varphi_\nu} \right)^{1-\sigma} - (f + n f_M) & \text{imported intermediates} \\ \Gamma_{X\nu} \varphi^{*1-\sigma} f \left(\frac{\bar{W}}{\varphi_\nu} \right)^{1-\sigma} - (f + n f_X) & \text{exported final goods} \\ \Gamma_{X\nu} \Gamma_{M\nu} \varphi^{*1-\sigma} f \left(\frac{\bar{W}}{\varphi_\nu} \right)^{1-\sigma} - [f + n(f_X + f_M)] & \text{imp'd interm's \& exp'd final gds} \end{cases}$$

Clearly for any individual firm ν , the $\lim_{\hat{\varphi}^* \rightarrow 0} \pi_\nu(\lambda_\nu, \bar{W}, \hat{\varphi}^*) = \infty$, because this is true for each mode of globalization, hence also for the maximum. But if this is true for every firm, then it is also true for average profits $\lim_{\hat{\varphi}^* \rightarrow 0} \bar{\pi}_\nu(\lambda_\nu, \bar{W}, \hat{\varphi}^*) = \infty$. But with average profits

$\bar{\pi}_\nu(\lambda_\nu, \bar{W}, \hat{\varphi}^*) \leq \bar{\pi}(\lambda_\nu, \hat{\varphi}^*)$, it must also be true that $\lim_{\hat{\varphi}^* \rightarrow 0} \bar{\pi}_\nu(\lambda_\nu, \hat{\varphi}^*) = \infty$. This completes the proof of the existence of equilibrium.

We now examine the question of the uniqueness of equilibrium. The equilibrium is unique if the ZCP curve cannot cut the FE curve from below. Equivalently, this requires that for any $(\bar{\pi}, \hat{\varphi}^*)$ on the FE curve, the elasticity of $\bar{\pi}$ with respect to φ^* is greater along the FE than along the ZCP curve.

Direct calculation shows:

$$\frac{\partial \bar{\pi}_{FE}}{\partial \hat{\varphi}^*} \frac{\hat{\varphi}^*}{\bar{\pi}} = g(\hat{\varphi}^*) \hat{\varphi}^*$$

For fixed $\hat{\varphi}^*$, $\pi(\varphi; \hat{\varphi}^*) \geq 0$ and strictly increasing in φ , with the consequence that

$$\bar{\pi}_{ZCP}(\hat{\varphi}^*) > 0.$$

Note also that $\frac{\partial \pi(\lambda_v, \hat{\varphi}^*)}{\partial \hat{\varphi}^*} < 0$, which reflects the fact that if a higher productivity firm is

earning zero profits, this must be because its demand curve has shifted in.

We now look at the change in average profits when $\hat{\varphi}^*$ rises:

$$\begin{aligned} \frac{\partial \bar{\pi}_{ZCP}}{\partial \hat{\varphi}^*} &= \frac{g(\hat{\varphi}^*)}{1 - G_\Phi(\hat{\varphi}^*)} \int_{\hat{\varphi}^*}^{\infty} \int_{t_M}^{\infty} \int_{t_X}^{\infty} \pi(\lambda_v, \hat{\varphi}^*) g(\lambda_v) dt_X dt_M d\varphi \\ &+ \frac{1}{1 - G_\Phi(\hat{\varphi}^*)} \left[\int_{\hat{\varphi}^*}^{\infty} \int_{t_M}^{\infty} \int_{t_X}^{\infty} \frac{\partial \pi(\lambda_v, \hat{\varphi}^*)}{\partial \hat{\varphi}^*} g(\lambda_v) dt_X dt_M d\varphi - \int_{t_M}^{\infty} \int_{t_X}^{\infty} \pi(\hat{\varphi}^*, \hat{\varphi}^*) g(\lambda_v) dt_X dt_M \right] \end{aligned}$$

Noting that $\pi(\hat{\varphi}^*; \hat{\varphi}^*) = 0$ and $\frac{\partial \pi(\hat{\varphi}^*, \lambda_v)}{\partial \hat{\varphi}^*} < 0$, the second term of the sum is negative, so that

$$\frac{\partial \bar{\pi}_{ZCP}}{\partial \hat{\varphi}^*} < \frac{g(\hat{\varphi}^*)}{1 - G(\hat{\varphi}^*)} \int_{\hat{\varphi}^*}^{\infty} \int_{t_M}^{\infty} \int_{t_X}^{\infty} \pi(\lambda_v, \hat{\varphi}^*) g(\lambda_v) dt_X dt_M d\varphi$$

The associated elasticity is then

$$\frac{\partial \bar{\pi}_{ZCP}}{\partial \hat{\varphi}^*} \frac{\hat{\varphi}^*}{\bar{\pi}} < g(\hat{\varphi}^*) \hat{\varphi}^* = \frac{\partial \bar{\pi}_{FE}}{\partial \hat{\varphi}^*} \frac{\hat{\varphi}^*}{\bar{\pi}}$$

This implies that the ZCP curve cuts the FE curve only from above, so cannot cut it more than once. This completes the proof of uniqueness of the autarky fair wage equilibrium.

There is a simple intuition about why uniqueness holds here, as in other Melitz-type models, which can be understood via an example. Consider two potential values of the cutoff, $\hat{\varphi}_1^*$ and $\hat{\varphi}_2^*$. Let $1 - G(\hat{\varphi}_1^*) = 2[1 - G(\hat{\varphi}_2^*)]$, so that a move from $\hat{\varphi}_1^*$ to $\hat{\varphi}_2^*$ cuts the probability of survival in half. To stay on the FE constraint, we must have $\bar{\pi}$ double to cover the constant expected per period entry cost of δf_e . Consider the same movement along the ZCP curve that eliminates half of the firms that initially exist. Two conditions would suffice to ensure that average profits along the ZCP also double. The first is that as the cutoff rises, all surviving firms are able to maintain their initial profits. The second is that the exiting firms have an aggregate profit of zero. Neither condition will be met. Every surviving firm finds that a rise in $\hat{\varphi}^*$ along the ZCP reduces its profits, even at an unchanged wage. And the exiting firms have positive

aggregate profits. For this reason, the ZCP can never rise faster than the FE when considered at a common $(\bar{\pi}, \hat{\varphi}^*)$. This yields uniqueness of equilibrium.

Proposition 3: A move to costly trade from autarky raises the equilibrium cutoff, i.e. $\varphi^* > \varphi^{*A}$.

The proof of this is immediate and follows the intuition from Melitz exactly. The Free Entry condition is entirely unchanged, while the Zero Cutoff Productivity curve with costly trade lies above that in autarky. To see this, fix a notional cutoff $\hat{\varphi}^*$ and note that at this notional cutoff, the profits of firms serving only the domestic market are entirely unchanged while those for firms that import intermediates or export must *ipso facto* be higher. Thus for a fixed $\hat{\varphi}^*$, the corresponding $\bar{\pi}$ is higher. With the ZCP curve having shifted up, the equilibrium $\varphi^* > \varphi^{*A}$.

Proposition 4: A move to costly trade from autarky leads to:

- A. Exit of the least productive firms, $\varphi_v \in (\varphi^{*A}, \varphi^*)$.
- B. A decline in wages at all firms that serve only the domestic market.
- C. A decline in wages at marginal importers and marginal exporters.
- D. A rise in wages for sufficiently large exporters or importers.

Proposition 4A follows directly from Proposition 3. Proposition 4B requires only a couple of steps. First, from Equation (8), note that a rise in the equilibrium φ^* implies a decline in the size of any one market. Since the firms under consideration serve only the domestic market, the relevant profitability curve from Equation (6) has shifted in, implying lower profits and wages. Proposition 4C takes a marginal importer or exporter to be one that is indifferent between importing or exporting versus serving only the domestic market. The proposition then follows from two observations. The first is that, like all firms, they suffer a decline in profits in the domestic market. Second, by the definition of marginal exporter or importer, their profits net of fixed costs from exporting or importing are exactly zero, so they cannot compensate for the loss of profits in the domestic market. Taken together, these imply that profits, and thus wages, for marginal exporters or importers have fallen. We prove proposition 4D by showing that firms with very high productivity φ or unusually low idiosyncratic marginal costs of importing τ_{Mv} or exporting τ_{Xv} will find that their profits rise.¹ For the super-globalizing firms in these

¹ The positive effects of liberalization on opportunities and profits of exporters relative to domestically oriented firms can be viewed through a variety of lenses. In the case of symmetric tariff liberalization, the CIF cost of

dimensions, those that both export and import intermediate inputs, the globalization factors Γ_{xv} and Γ_{Mv} have a powerful synergistic effect on profits, as each raises the returns from the other (see Equation 13). These are also the firms at which wages will rise most sharply.

Proposition 5: All else equal, a firm that exports a larger share of its output or imports a higher share of its inputs will have higher profits and wages.

The proof is very simple. First, we note that once fixed costs are incurred, variations in physical marginal productivity affect the total amount of production, including for export, but do not affect the share that is exported. This follows directly from the constant elasticity character of Dixit-Stiglitz demands combined with the fact that the foreign to domestic price of the good is constant at τ_{xv} . Similarly, once a country imports intermediates, the share of intermediates imported is unaffected by the productivity, so scale, of the firm. Again, this follows from the homotheticity of the Dixit-Stiglitz intermediate demand combined with the constant relative price of imported to local intermediates of τ_{Mv} . Hence firm level variation in the shares of exports or imports are affected only by the idiosyncratic component of trade costs. All else equal, a decline in idiosyncratic export costs raises the share of output exported by increasing demand in foreign markets. This shifts out the associated profitability curve, raising both profits and wages. The same story holds for imports, where a decline in idiosyncratic elements of import costs raises the share of imported inputs due to lower landed prices, shifting out the profitability curve, and thus raising both profits and wages.

The Fair Wage Constraint and Firm Behavior

We now turn to the question of how the fair wage constraint affects firm behavior. Consider the general problem of a firm with inverse demand curve $p(q)$, fixed costs f , and marginal costs $c(\pi)$ that are increasing in the profitability of the firm. Then the firm's problem is to choose an output level to maximize profits, taking into account that profits themselves affect the marginal costs of the firm.

delivery to the foreign market declines, directly improving opportunities and profits for exporters. In a unilateral liberalization, the direct effect on the liberalizing country is to increase imports and competition locally. By itself, this lowers the domestic price index, reducing the level of domestic demand to all local producers. The import surge requires an adjustment of the real exchange rate to re-attain trade balance. This adjustment creates new profit opportunities for exporters but not domestic-only firms, providing for the differential profits, hence wage, opportunities.

$$(3) \quad \text{Max } \pi = p(q)q - cq - f \quad \text{s.t. } c = c(\pi) \quad \text{with } c'(\pi) > 0$$

Taking differentials, we find:

$$(4) \quad d\pi = p(q)dq + q \frac{dp}{dq} dq - cdq - q \frac{dc}{d\pi} d\pi$$

Solving, we find that the first order condition for profit maximization is that:

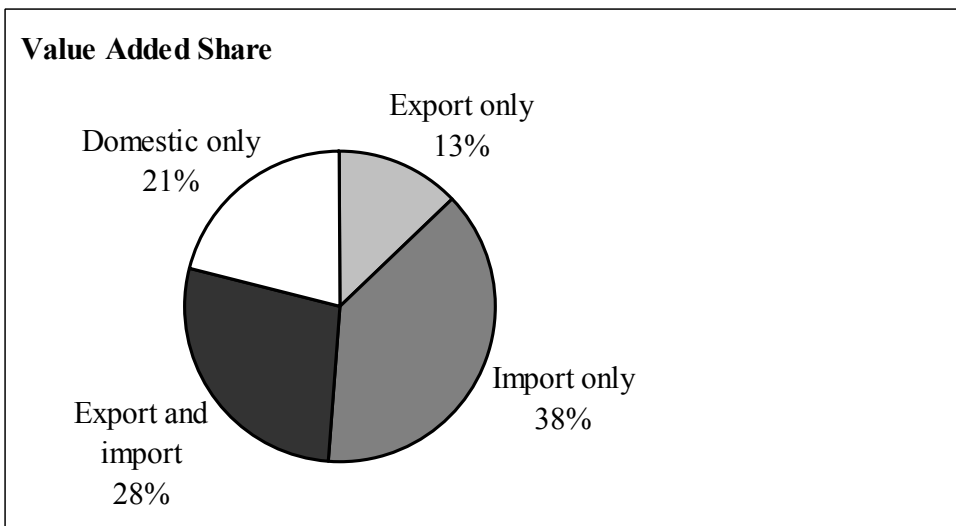
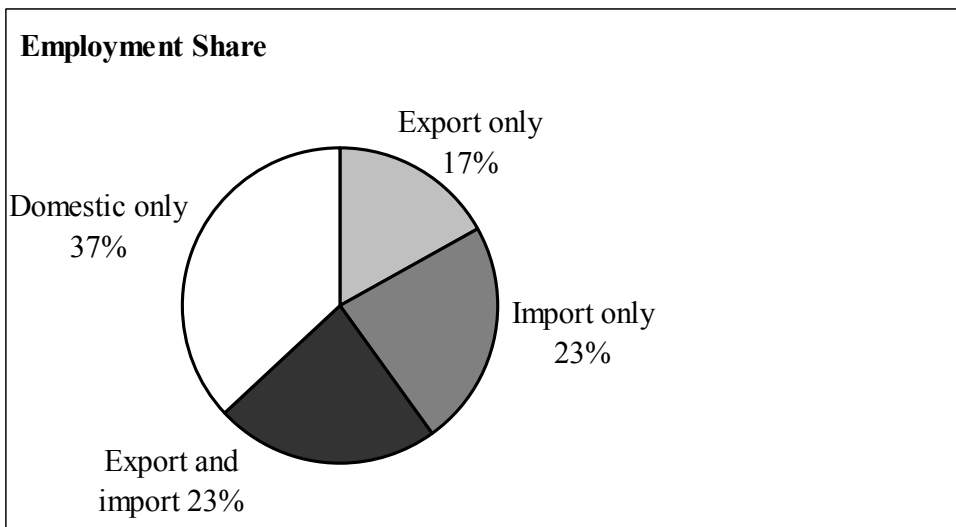
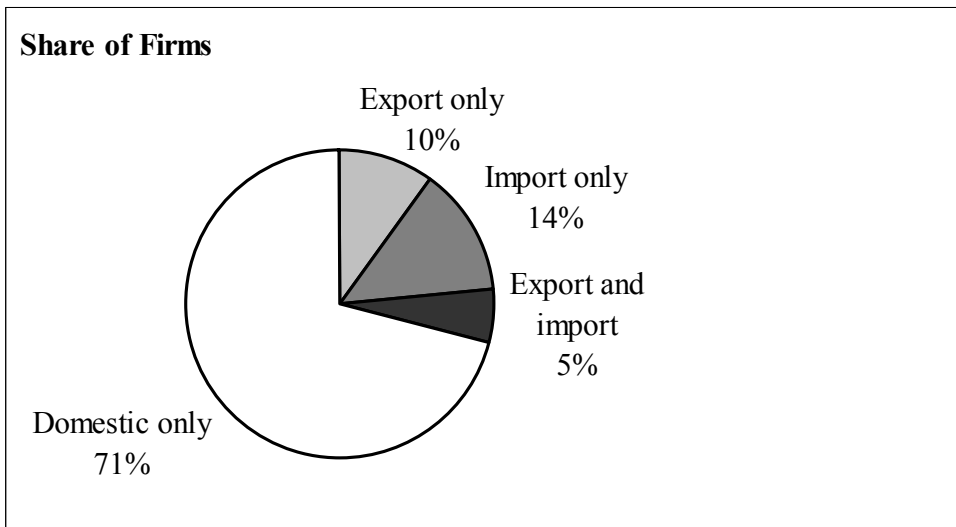
$$(5) \quad \frac{d\pi}{dq} = \left[\frac{1}{1 + q \frac{dc}{d\pi}} \right] \left(p(q) + q \frac{dp}{dq} - c \right) = 0$$

Note that the first term is always positive, so it doesn't affect the optimal choice of active firms. More importantly, the second term is just the conventional condition that marginal revenue equals marginal cost, with the associated inverse elasticity rule for pricing.

In short, although the firm is well aware that its choices affect its marginal cost, it makes the same price and output choices as if the marginal cost at the equilibrium were parametric. The reason is intuitive. The firm would like to manipulate its decisions to lower cost. But since cost is an increasing function of the firm's objective, there is no possibility of manipulating profit to lower cost without lowering profit as well. Thus, in what follows, the monopolistically competitive firms we study will act as if the wage is parametric at its equilibrium level and engage in conventional monopolistic competition behavior in pricing and output.

Appendix B

Figure B1. Firm Heterogeneity by Mode of Globalization



N = 185,866

Figure B2. Firm Level Wages Vary Greatly



Figure B3. Revenue and Wages 1991

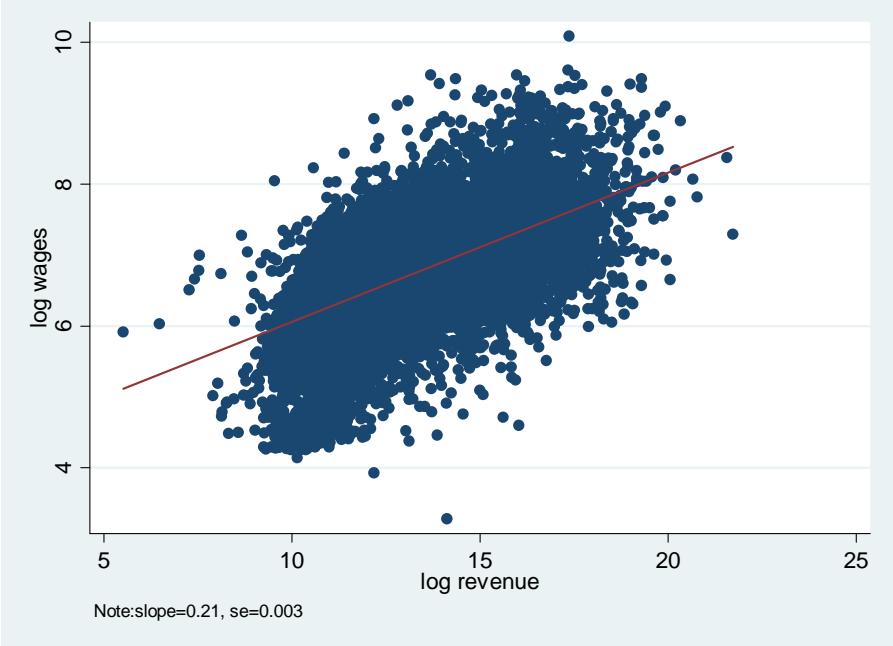


Figure B4. Change in Revenue and Change in Wages 1991 to 2000



Figure B5. Output Tariffs Vary Across Industries

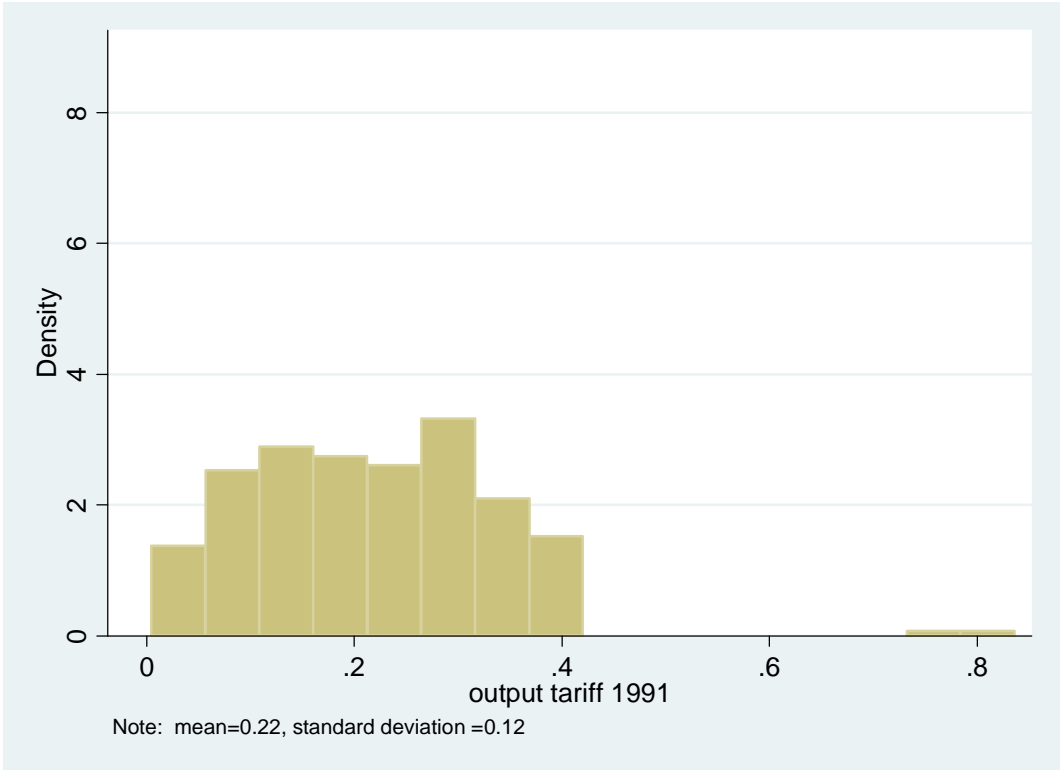


Figure B6. Input Tariffs Vary Across Industries

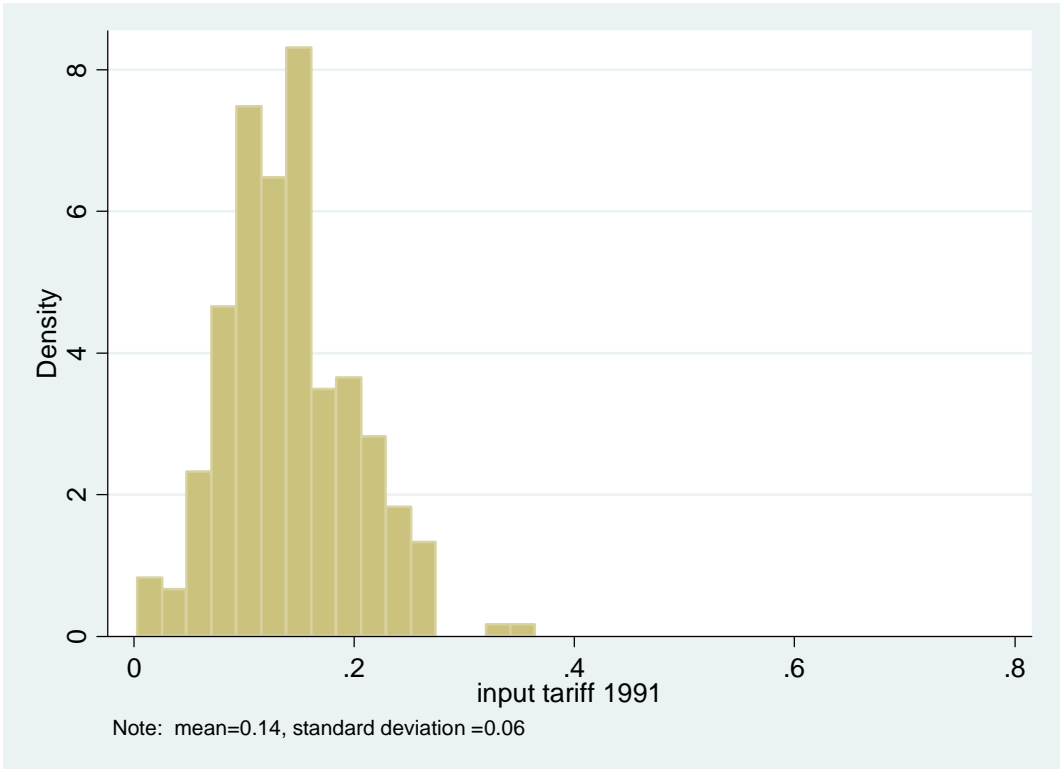


Figure B7. Tariff Levels on Inputs and Output are Weakly Correlated

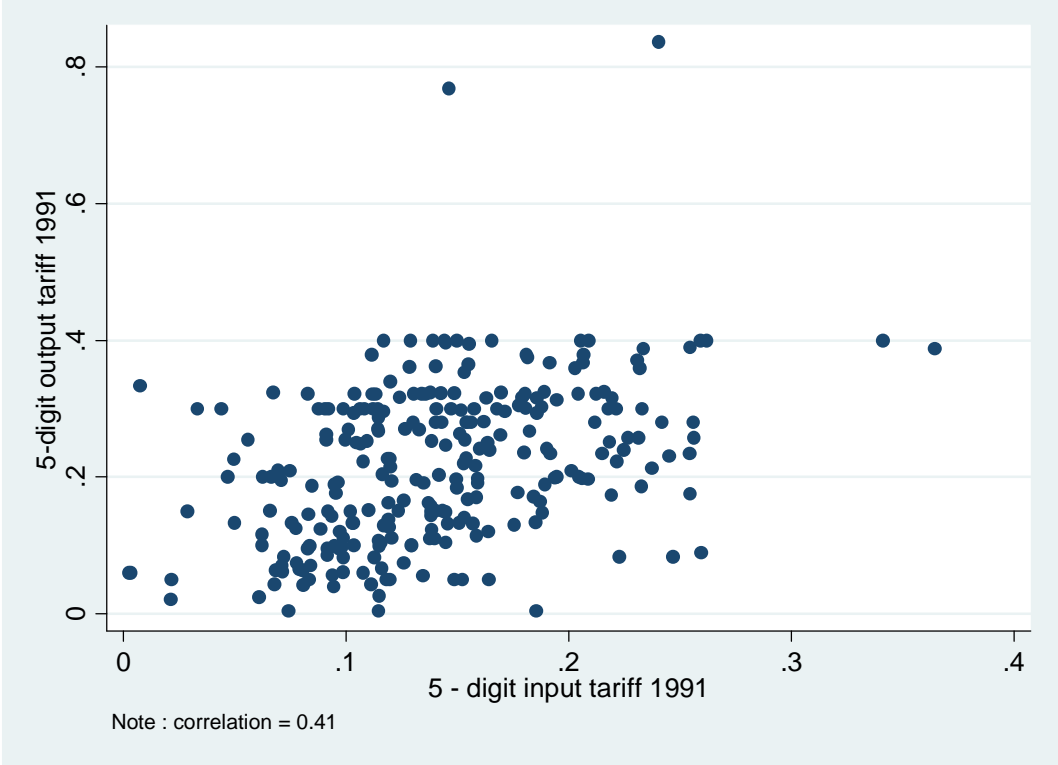


Figure B8. Changes of Input and Output Tariffs are Weakly Correlated

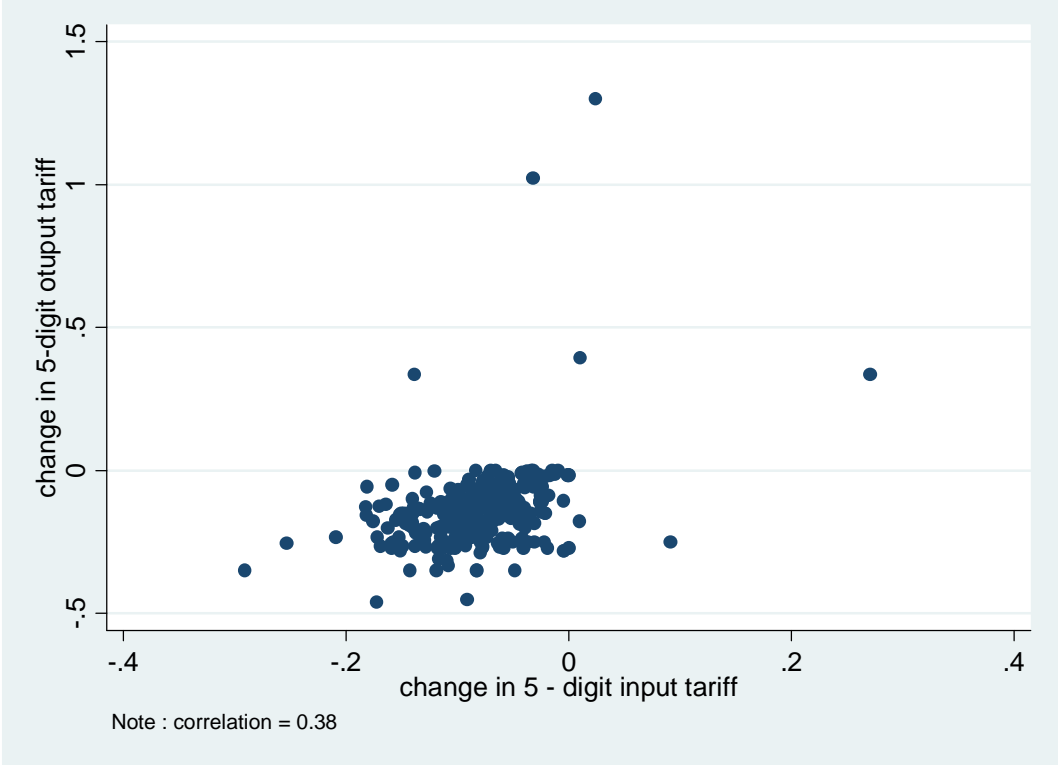


Table B1

| Dependent Variable | ln(wages) _{f,i,t} | ln(wages) _{f,i,t} |
|------------------------------------------------------------------------------------------|----------------------------|----------------------------|
| | (1) | With total revenue (2) |
| ln(revenue) _{f,i,t} | | 0.199*** (0.004) |
| Output tariff _{f,i,t} | 0.107** (0.051) | 0.112*** (0.045) |
| Output tariff _{f,i,t} x FX _{f,i,t} | -0.206*** (0.043) | -0.126*** (0.040) |
| Input tariff _{f,i,t} | -0.017 (0.099) | -0.043 (0.090) |
| Input tariff _{f,i,t} x FM _{f,i,t} | -0.504*** (0.085) | -0.375*** (0.079) |
| FX _{f,i,t} | 0.055*** (0.009) | 0.026*** (0.009) |
| FM _{f,i,t} | 0.096*** (0.011) | 0.046*** (0.010) |
| skillshare _{f,i,t} | 0.272*** (0.020) | 0.262*** (0.018) |
| Δln(labor) _{f,i,t} | -0.078*** (0.006) | -0.237*** (0.006) |
| Foreign share _{f,i,t} | 0.137*** (0.018) | 0.077*** (0.017) |
| Government share _{f,i,t} | 0.053*** (0.009) | 0.050*** (0.010) |
| Exit _{f,i,t} if exit in t+1 | -0.50*** (0.006) | -0.033*** (0.005) |
| Fixed Effects: | | |
| Location-year | yes | yes |
| Firm | yes | yes |
| Joint Significance tests Ho: sum of coefficients on tariff variables equals zero. | | |
| Output tariffs | -0.098* (0.057) | -0.013 (0.052) |
| Input tariffs | -0.521*** (0.116) | -0.418*** (0.107) |
| Observations | 173,732 | 173,732 |
| Adjusted R ² | 0.83 | 0.84 |

One approach to assessing the relative importance of the profit channel is to include profits in the wage equation in column 1 of Table 5 to see how much of the effect from tariffs works through profits. In Table B1, we have re-estimated the equation in column 1 of Table 5, with wages as the dependent variable, first without $\ln(\text{revenue})$ as an explanatory variable and in the second column we include $\ln(\text{revenue})$. We keep the sample sizes the same in both columns so that we can do a direct comparison of the results. The magnitude of the effect on wages of exporters and importers is lower in the second column as we can see from comparing the joint significance tests at the bottom of the table. The effect from output tariffs on exporters becomes statistically insignificantly different from zero, and the effect on importers is now lower but still significant. However, it is difficult to draw conclusions about how much of the effect from tariffs works through profits from this specification. Although revenues are positively correlated with profits, they are in fact not a good measure of profits, which gives us pause about interpreting the results too strongly. To illustrate, Equation 3 shows that $\text{Revenue}_v = \sigma * (\text{Profits}_v + \text{Fixed costs}_v)$. We see that revenue is positively related to profits but it is also related to the idiosyncratic firm fixed costs, which are themselves correlated with profits by the fact that they reflect globalization decisions.

The regression with revenues as the dependent variable in column 1 of Table 5 in the paper provides some suggestive evidence in support of the profit mechanism. However, we consider the inclusion of revenues as an additional explanatory variable problematic. From the equation above, we can see that it would immediately imply an omitted variable problem (the idiosyncratic firm fixed costs) which are correlated with revenues but would end up in the error term i.e. it may be that all the effects from wages on tariffs are indeed coming from profits but we can't see this from the table below because we are missing measures of the firm fixed cost, which are likely to also have nonlinear effects. Given that the coefficient on revenues is likely to be a biased estimate of the true coefficient on profits due to the missing profits components and the potential endogeneity bias, it is difficult to infer how much of the effect of tariffs on wages actually works through profits.