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Mary Amiti and Donald R Davis

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Mary Amiti, Federal Reserve Bank of New York and CEPR
Donald R Davis, Columbia University and NBER

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Centre for Economic Policy Research
90–98 Goswell Rd, London EC1V 7RR, UK
Tel: (44 20) 7878 2900, Fax: (44 20) 7878 2999
Email: cepr@cepr.org, Website: www.cepr.org

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ABSTRACT

Trade, Firms, and Wages: Theory and Evidence*

How does trade liberalization affect wages? This is the first paper to consider in theory and data how the impact of final and intermediate input tariff cuts on workers' wages varies with the global engagement of their firm. Our model predicts that a fall in output tariffs lowers wages at import-competing firms, but boosts wages at exporting firms. Similarly, a fall in input tariffs raises wages at import-using firms relative to those at firms that only source locally. Using highly detailed Indonesian manufacturing census data for the period 1991 to 2000, we find considerable support for the model's predictions.

JEL Classification: F10, F12, F13 and F14
Keywords: firm heterogeneity, input tariffs, output tariffs, trade liberalization and wages

Mary Amiti
International Research
Federal Reserve Bank of New York
33 Liberty Street
New York, NY 10045-0001
USA
Email: mary.amiti@ny.frb.org

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Donald R Davis
Department of Economics
Columbia University
1038 Intl. Affairs Building
420 West 118th Street
New York, NY 10027
USA
Email: drdavis@columbia.edu

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1. Introduction

How does trade liberalization affect wages? This is one of the most important questions in international economics, one that has generated a vast theoretical and empirical literature.[1] Yet no contribution to this literature has simultaneously addressed the two most salient facts to emerge in the last decade about international production. The first fact is the role of firm level heterogeneity in export and import behavior. As emphasized in Andrew B. Bernard et al. (2007), exporting and importing are concentrated in a small number of firms that are larger, more productive, and pay higher wages. The second fact is the large and growing importance of trade in intermediates, as documented by Kei-Mu Yi (2003). A distinct role for intermediates is of considerable importance, as well, because of the contrasting protective and anti-protective effects of final and intermediate tariffs respectively.

The contribution of this paper is to examine, theoretically and empirically, the impact of trade liberalization on wages while taking explicit account of both of these facts. We develop a general equilibrium model which features firm heterogeneity, trade in final and intermediate products, and firm-specific wages. In doing so, it builds on the work on heterogeneous firms of Marc J. Melitz (2003) as amended to allow trade in intermediate goods by Hiroyuki Kasahara and Beverly J. Lapham (2007). Both of these models maintain the assumption of homogeneous labor and a perfect labor market, so that the wages paid by a firm are disconnected from that firm's performance. We continue to focus on homogeneous labor, but introduce a novel variant of fair wages which links the wages at a firm to the profitability of the firm.[2]

The key theoretical result is that the wage consequence of a particular tariff change depends on the mode of globalization of the firm at which a worker is employed.

[1] For recent contributions, see the papers in Ann E. Harrison (2007) and the surveys by Pinelopi K. Goldberg and Nina Pavcnik (2007) and Robert C. Feenstra and Gordon H. Hanson (2003).

[2] The fair wage literature, following George A. Akerlof (1982) and Akerlof and Janet L. Yellen (1990), has addressed a variety of issues in macro and labor economics. It has been applied in recent years to issues of international trade by Gene M. Grossman and Elhanan Helpman (2007) as well as Hartmut Egger and Udo Kreickemeier (2006). While much of the fair wage literature has focused on within firm references, Eric A. Verhoogen, Stephen V. Burks, and Jeffrey P. Carpenter (2007) demonstrate the importance of external references for fairness. Our model takes a particular specification of the internal and external reference points, respectively the profitability of one's own firm and the wage paid at zero profit firms. David I. Levine (1993) notes that while compensation executives typically do not take "ability to pay" (profits here) into account in recommending wage changes, this consideration nevertheless enters because top executives do take this into account when deciding whether to implement raises or cuts in pay. See also Daniel Kahneman, Jack L. Knetsch, and Richard Thaler (1986).

A decline in output tariffs reduces the wages of workers at firms that sell only in the domestic market, but raises the wages of workers at firms that export. A decline in input tariffs raises the wages of workers at firms using imported inputs, but reduces wages at firms that do not import inputs. And there is a synergy in these effects so that exporting or importing magnifies the effect of the other.

We test our model's hypotheses with a rich data set covering the Indonesian trade liberalization of 1991-2000. The trade liberalization provides us with over 500 price changes per period, covering both input and output tariffs. A distinctive feature of the Indonesian data set is the availability of firm level data on individual inputs, making it possible to construct highly disaggregated input tariffs. This, in turn, enables us to disentangle the effects of output and input tariffs. The data covers a period with a very substantial liberalization of both types of tariffs, with important variation across and within industries. From 1991 to 2000, average output tariffs fell from 21 percent to 8 percent, while average input tariffs fell from 14 percent to 6 percent. Further, the data include information on firm level importing and exporting behavior, allowing us to identify the differential effects of trade liberalization on exporters, importers, and domestically oriented firms.

The results of our study are very striking. First, heterogeneity matters. Not only are firms affected in a heterogeneous way by trade liberalization, but so are the wages of their workers. Second, modes of globalization matter. Liberalization in final and intermediate goods trade have distinct impacts on the fate of workers according to the modes of globalization of the firms at which they work. A 10 percentage point fall in output tariffs decreases wages by 3 percent in firms oriented exclusively toward the domestic economy. But the same fall in the output tariff *increases* wages by up to 3 percent in firms that export. A 10 percentage point fall in input tariffs has an insignificant effect on firms that don't import, but *increases* wages by up to 12 percent in firms that do import. In short, liberalization along each dimension raises wages for workers at firms which are most globalized and lowers wages at firms oriented to the domestic economy or which are marginal globalizers. Ours is the first paper to show an empirical link between input tariffs and wages, and the first to show differential effects from reducing output tariffs on exporters and non-exporters.

Our results have both parallels with, and divergences from, findings in previous studies. The literature has found inconsistent results of the effect of output tariffs cuts on wages. For example, both the industry-level study on Colombia by Goldberg and Pavcnik (2005) and the firm-level study on Mexico by Ana Revenga (1997) associate a cut in output tariffs with a decline in industry and firm wages respectively. However the industry-level study on Brazil by Pavcnik et al. (2004) and the firm-level study of NAFTA by Daniel Trefler (2004) find insignificant or near zero effects of a decline in output tariffs on wages. None of the prior studies has found that cuts in output tariffs *raise* the wages of workers at some firms. Our approach, which allows the effect of output tariffs on firm wages to depend on the firm's export orientation, may explain the prior mixed results due to the pooling of groups of firms with disparate responses.

Differential firm-level wage responses between exporters and non-exporters arise in Verhoogen (2008). However, the experiment he considers is not a trade liberalization, but rather an exchange rate depreciation. Implicitly this is a movement in a single price. But the same devaluation that makes exporting more attractive makes importing intermediates less attractive, and one can hope at best to ascertain the net of the two effects. The first study to place imported intermediates at the heart of a discussion of wage evolution is Feenstra and Hanson (1999). But their study only considers economy-wide wage changes and their empirical exercise includes no explicit measures of changes in the costs of importing intermediates (tariff reductions or otherwise). Indeed no prior study has used explicit measures of liberalization in intermediate tariffs to estimate wage effects.

Our empirical results directly address the effect of tariff liberalization on firm-level wages, but the results have broader implications. The theoretical results encompass any element of globalization in which there is a change in the relative marginal cost of serving final goods markets or sourcing inputs from foreign versus domestic markets. This would include changes in transport costs, regulation, or other barriers that affect these relative marginal costs. From this perspective, the advantage of our experiment in understanding the broader process of globalization is that tariff liberalization allows these changes in relative marginal costs to be measured precisely and so give us greater ability to identify the consequences for firm level wages.

2. Theory

The central question we explore is how heterogeneous patterns of global engagement by firms within an industry translate into different wage outcomes for workers employed by those firms following trade liberalization. We develop a model which matches stylized facts in our data. First, the data show that only some firms engage in exporting and importing. Thus, our starting point is the theory of Melitz (2003), which emphasizes the heterogeneity of firms in their export patterns, as developed by Kasahara and Lapham (2007) to allow for global integration via trade in both intermediate and final goods.

Second, the firm-level data underscores the tremendous degree of wage variation within industries, thus we need to incorporate this additional dimension of heterogeneity to the models by Melitz (2003) and Kasahara and Lapham (2007). Both of their models maintain the assumption of homogeneous labor and a perfect labor market. We must depart from at least one of these to generate the firm-level wage heterogeneity. To this end, we add a single hypothesis – that the wage paid at firms to homogeneous labor is increasing in the aggregate profits at those firms. From this, we will be able to develop the core predictions to be tested by the data. It is important to note that such a relationship between wages and the profitability of firms could emerge from a variety of more fundamental premises. Here we will develop it as a consequence of "fair wage" concerns; but it might reflect bargaining between workers and firms; and perhaps other interpretations. The changes in wages observed could also arise because of a correlation between underlying worker heterogeneity across firms and the available gains from global integration.[3] At present, our data will not be able to discriminate between these alternative interpretations of our results, so we stay with the simpler hypothesis.[4]

Although some recent papers have introduced imperfections in labor markets to the heterogeneous firm model, their approaches are not suitable for our purpose. Gabriel J. Felbermayr et al. (2008) and Helpman and Oleg Itskhoki (2007) have considered

[3] As, for example, in Yeaple (2005).

[4] Mahmood Arai (2003) finds a strong link between hourly wages and firm profitability in Sweden across a wide range of worker types (blue and white collar), labor organizations (union and non-union) and industrial sectors (manufacturing versus non-manufacturing). Using matched worker-firm data, he is able to control for unobserved worker characteristics. Although there is some sorting of high educated workers into profitable firms, he finds that workers with unobserved high ability are distributed randomly across firms with different levels of profitability. Thus, controlling for unobserved worker heterogeneity does not affect the correlation between firm profits and wages.

search costs. While search costs give rise to wage heterogeneity across different industries with distinct search technologies, they do not give rise to wage heterogeneity at the firm level within an industry, which is what we need. Donald R. Davis and James Harrigan (2007) have derived heterogeneous wages by introducing firm-specific monitoring costs into an efficiency wage version of Melitz. Their approach is not suitable for the present investigation because trade liberalization has no impact on relative wages across firms. Egger and Kreickemeier (2006) have also explored a "fair wage" version of the Melitz model. Their approach is likewise too restrictive for present purposes because liberalization leads all firm-level wages to move in the same direction. Our approach of combining a fair wages model with the Melitz-Kasahara-Lapham framework of heterogeneous firms which trade in intermediate and final goods markets allows for quantitatively different firm-level responses to changes in input and output tariffs.

A. Consumption of Final Goods

Consumers allocate expenditures E across available final good varieties to:

$$\text{Min } E = \int p(\nu)q(\nu)d\nu$$

(1)

$$s.t. \left[\int q(\nu)^{\frac{\sigma-1}{\sigma}} d\nu\right]^{\frac{\sigma}{\sigma-1}} = U$$

These deliver demand curves for final product ν of the form:

$$q(\nu) = \left[\frac{p(\nu)}{P}\right]^{-\sigma} Q$$

and revenue of the form:

$$r(\nu) = R\left[\frac{p(\nu)}{P}\right]^{1-\sigma}$$

where $Q \equiv U$, P is an aggregate price index given by

$$P = \left[\int_{\nu\in V} p(\nu)^{1-\sigma} d\nu\right]^{\frac{1}{1-\sigma}}$$

and $PQ = R$.

The demand curve above is a key input to the final good producer's problem.

B. Production, Profits, and Modes of Globalization

This section describes firm behavior with respect to key variables and, in particular, to consider how this is affected by modes of globalization. The main result from this section will be a relation, for each of these modes, between profits of the firm and the wage paid by the firm. The next section will develop the equilibrium wage paid by the firm en route to determining market equilibrium.

There are two sectors of production, intermediate and final goods, produced with a single homogeneous factor, labor. Intermediates are available in each country in a fixed measure of varieties on the unit interval, $m(j)$ for $j \in [0,1]$. They are produced with free entry under constant returns to scale and priced at marginal cost. Units are chosen so that one unit of labor produces a unit of intermediates. Labor employed in the intermediates sector is chosen as the numeraire, which implies that both the wage in this sector and the local price of intermediates are unity. At this price, intermediate suppliers stand ready to meet any demand emanating from the final goods sector.[5]

In the final goods sector, the sequence of decision problems is based on Melitz (2003). From an unbounded mass of potential firms, a mass M_e pays a fixed cost f_e in units of labor, with each firm ν learning its productivity $\varphi(\nu)$, drawn from the cumulative distribution function $G(\varphi)$, as well as the idiosyncratic components of marginal trade costs in imports $t_{M\nu}$ and exports $t_{X\nu}$ (see below). After learning their characteristics, some firms exit without producing, and the remaining mass M of firms will choose labor and intermediate inputs as well as final outputs destined for each market to maximize profits. There is a constant hazard rate δ of firm death. Steady state requires that new entry matches firm exits.

At any point in time, the individual final goods producer maximizes profits, taking the demand curve as given. We assume that all fixed-cost activities pay a wage in constant proportion to that available in the competitive intermediates sector, which for convenience we set at unity. However, we will focus on firm-specific wages W_ν in variable cost activities that arise in equilibrium, as developed below. In order to produce

[5] This approach focuses attention on the role of trade in intermediates on productivity and wages in the final goods sector while simplifying by ruling out feedback effects on the range of available intermediate varieties produced in a given market.

in any period, a final goods firm is required to employ f units of labor in fixed costs. With the fixed costs incurred, production is Cobb-Douglas in labor and intermediates.

Profits for a firm in the isoelastic setting with constant marginal costs are generically given as:

(2) $$\pi_\nu = Max\left[0, \frac{r_\nu}{\sigma} - F_\nu\right]$$

The fixed cost F_ν for a firm is a function of the mode of globalization.

(3) $$F_\nu = \begin{cases} f & \text{if domestic only} \\ f + nf_M & \text{if import intermediates} \\ f + nf_X & \text{if export final goods} \\ f + n\left(f_X + f_M\right) & \text{if export final goods and import intermediates} \end{cases}$$

In each of the $n+1$ countries, a unit measure of intermediates is produced with labor only under free entry and constant returns to scale. From above, the price of any domestic intermediate is unity, as is the FOB price of exported intermediates. The common landed CIF price for imported intermediates is $\tau_M > 1$, but we assume there is also a firm-specific iceberg component, $t_{M\nu} \in \left[1, \overline{t_M}\right]$, that reflects a firm's own capability in using imported intermediates. Hence the total effective price to a firm ν is $\tau_{M\nu} = \tau_M t_{M\nu} > 1$. Liberalization is assumed to affect only the common marginal import cost term τ_M. A firm with lower idiosyncratic intermediate trade costs can more easily cover the common fixed import cost, so will begin to import at a lower level of idiosyncratic output productivity. Because low idiosyncratic import costs reduce the relative price of imported inputs, such a firm will also use a higher share of imported (relative to locally produced) intermediates.[6]

[6] We add these additional dimensions of firm heterogeneity to match cross-sectional features of the data. If, as in Melitz, the marginal physical productivity parameter ϕ were the only dimension of firm heterogeneity, then we could have at most three of the four types of firms active (either all exporters would also import or all importers would also export, rather than allowing each separately). Introduction of one additional dimension of firm heterogeneity would suffice to solve *this* issue. The reason for adding two additional dimensions of heterogeneity (export and import costs) is because, otherwise, all firms that export would export the same share of their output and all firms that import would import the same share of their inputs. The cross-sectional data strongly instead show large variation in export and import shares, hence motivate our assumptions. While we characterize $t_{X\nu}$ and $t_{M\nu}$ as trade costs, they can also be looked on as firm-specific marginal efficiencies respectively of penetrating foreign markets or using foreign inputs. All experiments considered in the paper consist of varying only common components of trade costs, τ_X and τ_M.

Final good firms' choices about importing intermediates will affect their costs. Marginal costs c_ν are Cobb-Douglas in the input prices:

$$(4) \qquad c_\nu = \frac{1}{\varphi_\nu}\left(\frac{W_\nu}{\alpha}\right)^{\alpha}\left(\frac{P_{M\nu}}{1-\alpha}\right)^{1-\alpha} = \frac{\kappa W_\nu^{\alpha} P_{M\nu}^{1-\alpha}}{\varphi_\nu} \quad \text{where} \quad \kappa \equiv \alpha^{-\alpha}\left(1-\alpha\right)^{-(1-\alpha)}$$

For now we assume that the firm treats the wage as parametric, a point we return to later. The price of the composite intermediate depends on whether intermediates are imported or not, due to love of variety in available intermediates. A firm that imports accesses n additional unit intervals of intermediates. The price is thus given by:

(5)

$$P_{M\nu} = \begin{cases} \left[\int_0^1 1^{1-\gamma} dj\right]^{\frac{1}{1-\gamma}} = 1 & \text{domestic intermediates only} \\ \left[\int_0^1 1^{1-\gamma} dj + \int_0^n \tau_{M\nu}^{1-\gamma} dj\right]^{\frac{1}{1-\gamma}} = \left[1 + n\tau_{M\nu}^{1-\gamma}\right]^{\frac{1}{1-\gamma}} < 1 & \text{domestic and imported intermediates} \end{cases}$$

Hence marginal costs are

$$(6) \qquad c_\nu = \begin{cases} \dfrac{\kappa W_\nu^{\alpha}}{\varphi_\nu} & \text{if no imported intermediates} \\ \dfrac{\kappa W_\nu^{\alpha}\left(1 + n\tau_{M\nu}^{1-\gamma}\right)^{\frac{1-\alpha}{1-\gamma}}}{\varphi_\nu} & \text{if imported intermediates} \end{cases}$$

The domestic price of a final good variety is a simple mark-up on marginal costs,

$$p_{\nu d} = \frac{\sigma}{\sigma - 1} c_\nu .$$

Revenue in the domestic market depends on the price there, as in $r_{\nu d} = RP^{\sigma-1} p_{\nu d}^{1-\sigma}$. Since importing intermediates affects cost, and so price, it also affects revenues:

$$(7) \qquad r_{\nu d} = \begin{cases} RP^{\sigma-1}\left(\dfrac{\kappa W_\nu^{\alpha}}{\rho\varphi_\nu}\right)^{1-\sigma} & \text{if no imported intermediates} \\ \Gamma_{M\nu} RP^{\sigma-1}\left(\dfrac{\kappa W_\nu^{\alpha}}{\rho\varphi_\nu}\right)^{1-\sigma} & \text{if imported intermediates} \end{cases}$$

Here $\Gamma_{M\nu} \equiv \left(1+n\tau_{M\nu}^{1-\gamma}\right)^{\frac{(1-\alpha)(1-\sigma)}{1-\gamma}} > 1$ is an "import globalization" factor, reflecting the reduced marginal costs due to the use of imported intermediates, which lowers prices and raises revenues.

Total revenues r_ν depend not only on the degree of penetration of any one market, but also on the effective number of markets served and the firm's efficiency in serving those markets. We assume that there are idiosyncratic iceberg costs for a firm to serve a foreign market, given by $\tau_{X\nu}$. These can be decomposed into a common export cost $\tau_X > 1$ and an idiosyncratic component $t_{X\nu} \in \left[1, \overline{t_X}\right]$, where $\tau_{X\nu} = \tau_X t_{X\nu}$. Revenues in a foreign market are reduced proportionally to those in the domestic market, reflecting the higher price faced by consumers in that market due to iceberg costs $\tau_{X\nu}$ on final goods exports. All else equal, a firm with idiosyncratically low export costs will enter exporting earlier than other firms and will export a higher share of its total output.

Hence we can compare the revenues available to a firm by serving its domestic market only, $r_{\nu d}$, with those available if it also exports:

$$(8) \qquad r_\nu = \begin{cases} r_{\nu d} & \text{no exports} \\ \Gamma_{X\nu} r_{\nu d} & \text{exports} \end{cases}$$

Here $\Gamma_{X\nu} \equiv \left(1+n\tau_{X\nu}^{1-\sigma}\right) > 1$ is an "export globalization" factor, reflecting the fact that in addition to the domestic market, exporting gives access to n additional markets, each of which is $\tau_{X\nu}^{1-\sigma} < 1$ times the size of the domestic market.

This gives us the complete set of dimensions of globalization, depending on whether intermediates are imported or final goods exported. Note that so long as profits are non-negative, these are related to revenues by $\pi_\nu = \frac{r_\nu}{\sigma} - F_\nu$. Let variable profits for a firm that is purely domestic be $\pi_{\nu dVar} = \left(\frac{RP^{\sigma-1}}{\sigma}\right)\left(\frac{\kappa W_\nu^\alpha}{\rho\varphi_\nu}\right)^{1-\sigma}$. Then profits for our four modes are given as:

$$\pi_\nu(W_\nu) = \begin{cases} \pi_{\nu dVar} - f & \text{domestic only} \\ \Gamma_{M\nu}\pi_{\nu dVar} - (f + nf_M) & \text{imported intermediates} \\ \Gamma_{X\nu}\pi_{\nu dVar} - (f + nf_X) & \text{exported final goods} \\ \Gamma_{X\nu}\Gamma_{M\nu}\pi_{\nu dVar} - [f + n(f_X + f_M)] & \text{imp'd interm's \& exp'd final gds} \end{cases} \tag{9}$$

Here we emphasize the dependence, for each mode of globalization, of profits on wages, which we can label $\pi_\nu(W_\nu) = \zeta(W_\nu)$, where $\zeta'(W_\nu) < 0$. We complement this with the development of what we will term the Fair Wage (FW) constraint.

B.1. Fair Wage Constraint

Let the real wage in variable cost activities at firm ν be given as $w(\nu) = \frac{W(\nu)}{P}$.

We assume that:

(1) Marginal firms that earn zero profits pay a wage equal to that available in the competitive intermediates sector, i.e. unity; and

(2) Other firms pay a real wage relative to that at the marginal firm that is increasing in the profitability of the firm.

Workers demand these wage premia as a condition of exerting effort because it is considered fair that more profitable firms pay higher wages. Firms are willing to pay these wages because it is a necessity for eliciting effort. The wages are not bid down because all workers are identical and once hired any other worker will likewise demand the fair wage. We assume that workers need not queue for these jobs, but instead accept any job offered so long as they are not currently employed at a job paying more. Letting firm ν_0 be a zero profit firm, we have that:

$$\begin{aligned} \frac{w_\nu}{w_{\nu_0}} &= \frac{W_\nu / P}{W_{\nu_0} / P} = \frac{W_\nu / P}{1 / P} \\ &= W_\nu \\ &= \psi(\pi_\nu) \end{aligned} \tag{10}$$

In short, the Fair Wage Constraint determines that the nominal wage on offer at the zero profit firm is unity while that at any other firm ν is an increasing function of the profitability of that firm, represented by $W_v = \psi(\pi_v)$. We assume that this is a stable behavioral relation, with $0 < \psi'(\bullet) < \infty$. Figure 1 illustrates the Fair Wage Constraint.

Up to now, we have assumed that the firm treats the wage as parametric. This turns out to be innocuous, even though the firm recognizes that its actions affect the wages it pays. The temptation for the firm would be to try to alter its actions to reduce wages. However, the fact that the wage is increasing in the firm's own objective leaves the firm no room to exercise monopsony power, since it could pay lower wages in equilibrium only if it also has lower profits.

For a given demand curve, the firm can trace out profits and wages for each mode of globalization and will select that mode that maximizes its profits, thereby also determining the firm wage.

C. Equilibrium in the Closed Economy

We have developed the individual firm's choices conditional on the demand curve it faces. We now need to develop the market equilibrium that determines the relevant demand curve. We do this first for the simpler case of autarky.

Equilibrium in the closed economy is developed similar to Melitz (2003), involving two relations between average profits and the marginal firm as indexed by its productivity. The first of these is the Free Entry (FE) condition and the second is the Zero Cutoff Productivity (ZCP).

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 φ^* be the productivity of the marginal firm, this can be written:

(11) $$\bar{\pi} = \frac{\delta f_e}{\left[1 - G(\varphi^*)\right]}$$

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

With the Fair Wage constraint in hand, we can proceed to develop the ZCP curve. The ZCP curve embodies a relation between the marginal firm, indexed by its productivity, and the average profits of all active firms. As a start, note that all potential firms face identical demand curves; heterogeneity appears only from the cost side.

Consider the problem for a case in which a firm with productivity φ_0 is the zero profit firm. From the FW constraint, $W\left(\pi\left(\varphi_0\right)\right)=W\left(0\right)=1$. Hence

$$\begin{aligned}
\pi\left(\varphi_0,W\left(\varphi_0\right)\right) &= \left(\frac{RP^{\sigma-1}}{\sigma}\right)\left(\frac{\kappa W_0^{\alpha}}{\rho\varphi_0}\right)^{1-\sigma} - f \\
&= \left(\frac{RP^{\sigma-1}}{\sigma}\right)\left(\frac{\kappa}{\rho\varphi_0}\right)^{1-\sigma} - f \qquad (12) \\
&= 0
\end{aligned}$$

In the context of Figure 1, the firm with productivity φ_0 would have the profit curve associated with serving the domestic economy only cut the vertical axis at $W=1$.

Solving the zero profit equation, we find that

$$RP^{\sigma-1}=\sigma f\left(\frac{\kappa}{\rho\varphi_0}\right)^{\sigma-1} \qquad (13)$$

Inserting this into the profit function of any other firm, we have the relation

$$\pi\left(\varphi,W\right)=-f+f\left(\frac{\varphi}{\varphi_0}\right)^{\sigma-1}W^{\alpha(1-\sigma)} \qquad (14)$$

That is, the cutoff delivers precisely the information needed to determine all other firm profits and wages, as developed above.

With profits determined according to firm type and the cutoff φ_0 determining the distribution of active firm types $\mu\left(\varphi\right)=\dfrac{g\left(\varphi\right)}{1-G\left(\varphi_0\right)}$, we can also calculate average profits conditional on this cutoff $\bar{\pi}_0$. The pair $\left(\bar{\pi}_0,\varphi_0\right)$ determines one point on the ZCP curve. The entire ZCP curve is derived by repeating this for each potential cutoff productivity. The intersection of the ZCP curve and the FE curve determine average profits and the equilibrium cutoff $\left(\bar{\pi},\varphi^*\right)$.

An equilibrium always exists. Kasahara and Lapham (2007) can be considered a special case of this for $W\left(\bullet\right)=\psi\left(\bullet\right)\equiv 1$. Moreover, note that the ZCP for Kasahara and Lapham provides an upper bound for the ZCP here, since conditional on the cutoff, the profits for each firm are defined precisely as here, but the wage paid by each firm is higher (except for the cutoff firm), meaning that all other firms have lower profits. Hence the equilibrium here will feature a broader range of firm types than in Kasahara and Lapham, with the higher probability of survival compensating firms for lower expected profits. This determines the distribution of firm types and all aggregate variables for the closed economy.

D. Equilibrium in the Open Economy

We now develop the equilibrium in the open economy. We assume that fixed costs of exporting are at least as high as fixed costs for serving the domestic market, i.e. $f_X \geq f$, and that the dispersion of the idiosyncratic component of import costs $t_{M\nu}$ is not so great as to allow for a zero profit firm to import.[7]

With these assumptions in hand, we proceed as before to develop the ZCP curve. Taking a productivity φ_0 as given, the zero profit condition implies as before that $RP^{\sigma-1} = \sigma f \left(\frac{\kappa}{\rho \varphi_0} \right)^{\sigma-1}$. This provides each firm with productivity $\varphi \geq \varphi_0$ the ability to calculate profits for each mode of globalization. Actual profits and firm choices are governed by the maximum of the profits so derived. With firm profits determined, this allows us to calculate average profits as a function of the cutoff, i.e. each point on the ZCP curve.

The ZCP curve with trade lies above that in autarky for essentially the same reason as in Melitz. Conditional on the cutoff, the demand curve in the domestic market is precisely the same under trade as in autarky. The new opportunities available via importing or exporting must at least weakly raise available profits for all firms. With the distribution of active firms determined purely by the cutoff, average profits associated with any cutoff point will rise. In turn, since the FE curve is unaffected by the opening to

[7] The restriction that the fixed costs of entering export markets weakly exceeds entering the domestic market, $f_X \geq f$, seems quite reasonable and, with positive marginal costs of trade, insures that firms that export earn positive profits (at least in the domestic market). The assumption on the limited dispersion of the idiosyncratic component of import costs simplifies our analysis by excluding the case in which a firm has a very bad productivity draw but just manages to survive due to its extraordinary efficiency in importing (see Kasahara and Lapham (2007) for the path of allowing for some zero profit firms to import). This doesn't seem particularly restrictive for our exercise given that zero profit firms are of zero measure in the theory while firms that don't import are in excess of 80 percent of the firms in our data. Note, though, that the idiosyncratic trade costs of both types do affect the equilibrium by affecting the profits of individual firms that do trade and thus feeding into the position of the ZCP curve.

trade, the upward shift of the ZCP curve implies that trade exhibits selection effects, raising the equilibrium cutoff productivity.

Wages follow profits. Hence to find out the qualitative impact of liberalization on wages at a particular firm, we need only look at the impact on profits at that firm. All firms that serve only the domestic market see their market and profits shrink, and so wages at these firms decline. Likewise, what may be termed “marginal globalizers” also see their profits fall. To see this, consider a firm at the margin between serving the domestic market only and any of the alternative modes of globalization. As we have noted, profits available in the domestic market alone have declined, and by definition of the margin, the incremental profits from being a marginal globalizer are zero. Hence there will be an interval of firms who succeed in penetrating global export and import markets but whose total profits still decline as a result of the move from autarky. Wages at marginal globalizers thus also fall. Finally, firms with very high productivity φ or unusually low idiosyncratic marginal costs of importing $\tau_{M\nu}$ or exporting $\tau_{X\nu}$, will find that their profits rise.[8] For the super-globalizing firms in these dimensions, globalization factors $\Gamma_{X\nu}$ and $\Gamma_{M\nu}$ have a powerful synergistic effect on profits, as each raises the returns from the other (see equation 9). These are also the firms at which wages will rise most sharply.

[8] The positive effects of liberalization on opportunities and profits of exporters relative to domestically oriented firms are also present for a unilateral liberalization. The Melitz (2003) model does not admit closed form solutions for the case of unilateral liberalization, but the basic forces at work are straightforward and in line with our discussion of multilateral liberalization. First, there is the direct effect. Start by holding wages fixed in the initial symmetric equilibrium. A unilateral reduction in the home tariff directly lowers the CIF price paid for foreign goods, and so shifts home demand toward foreign goods. This reduces demand for all home producers in the local market, but has a proportionally smaller effect on the profits of globalized firms, whose profits depend proportionally less on the home market. Second, there are additional general equilibrium effects that will form part of the full adjustment to balanced trade. These adjustments can be thought of as a rise in foreign relative to home income and a rise in the common elements of the foreign wage relative to the home wage (i.e. the relative price of intermediates in the two countries). The critical element is that the new export opportunities are available only to those firms that actually export. This need not reverse the pressure for wages to fall at home in the aftermath of a unilateral liberalization, but it will at minimum cushion any decline in profits, hence wages, for those firms that have export opportunities relative to those that do not.

3. Data Description

To take the theory to the data, we need three key ingredients. First, to establish a link between tariff cuts and firm-level wages we need firm-level data. For this, we rely on the Manufacturing Survey of Large and Medium-sized firms (Survei Industri, SI) for 1991 to 2000, in 290 5-digit ISIC industry categories.[9] The data set has wide coverage, with all firms with 20 or more employees included, accounting for 60 percent of manufacturing employment.[10]

Second, we highlight that the effect of tariff cuts on wages depends on whether employment is at a firm that is domestically or internationally oriented. To establish this, we draw on the firm-level information provided in the census on importers and exporters. For each plant in each year, the data set reports on the value of a firm's exports and the value of imported and domestically purchased intermediate inputs. [11]

Third, we identify separate effects on wages from cutting input tariffs to those from cutting output tariffs. This requires that the tariff data is sufficiently disaggregated to disentangle the two effects. A key ingredient in calculating disaggregated input tariffs is information on the type of inputs firms use. A unique feature of this data is that the SI questionnaire asks each firm to list all of its individual intermediate inputs and the amount spent on each. This information was coded up and made available to us by the Indonesian Statistical Agency (Badan Pusat Statistic, BPS) for the year 1998.

Before going to the estimation, we preview the data and highlight some stylized facts on wages, importers and exporters that are consistent with features of our model. Next, we explain how the tariff data are constructed and show the large variation in tariffs across industries and within industries and, most importantly, that input and output tariffs move differently.

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[9] Data is at the plant level and it is not possible to identify multiple plants pertaining to a common firm. For convenience in referring to the theory, we will use the terms "plant" and "firm" interchangeably. We begin our analysis in 1991 to avoid the reclassification of industry codes between 1990 and 1991.

[10] The data was cleaned by dropping the top and bottom 1 percentiles of the firm average wage level, and the top and bottom 1 percentiles of the year-to-year growth in firm average wages. We are left with a total of 185,866 observations. Summary statistics are provided in the Appendix.

[11] These imported inputs include inputs that are directly imported by the firm as well as imported inputs purchased from local distributors.

A. Importers, Exporters and Wages

Consistent with our model and patterns in other countries, only a small fraction of firms in Indonesia are engaged internationally. As Figure 2 reveals, only 5 percent of all firms both export and import; an additional 10 percent of firms export some of their output but don't import; and only 14 percent of firms import some of their inputs but don't export. While the globally engaged firms account for less than 30 percent of all firms, they are powerhouses, accounting for more than 60 percent of manufacturing employment and nearly 80 percent of the value added in the sample. Broadly similar patterns are evident in advanced countries, such as France (Jonathan Eaton, Samuel S. Kortum, and Francis Kramarz, 2004) and the United States (Bernard et al. 2007), as well as in developing countries such as Mexico (Verhoogen, 2008).

Most striking is the large variation in the wages paid by firms within the same industry. This can be seen in Figure 3 where we depict a firm's wage relative to the industry average in 1991. There is considerable wage heterogeneity across firms, with a standard deviation equal to 0.73. Around 14 percent of firms pay more than 50 percent of the industry mean and 16 percent pay less than 50 percent of the industry mean.

Closer inspection of the data reveals that wages vary greatly by type of firm. Comparing internationally engaged firms to domestically oriented firms in Table 1A, we see from column 1 that exporters pay 27 percent higher wages, importers pay 47 percent higher wages and firms that both import and export pay 66 percent higher wages. These wage differentials persist when we include industry fixed effects and control for the share of non-production workers and total employment, although the magnitudes fall. With these controls, and compared to domestically oriented firms, exporters pay 8 percent higher wages, importers pay 15 percent higher wages, and firms that import and export pay 25 percent higher wages. In short, even with these controls, wages vary systematically and substantially by the mode of firms' global engagement.

As in the model, it is the larger and more efficient firms that are globally engaged. As can be seen from Table 1B, domestically oriented firms rank lowest in terms of employment (columns 1 and 2), value added (columns 3 and 4), and total factor productivity (columns 5 and 6). The ranking between firms that import or export only is not tied down by theory and indeed varies by metric. However, in line with theory, in each case those firms that both import and export are the largest and most productive. For example, from the last two columns we see that firms that import and export are on average 20 percent more productive than domestically oriented firms.[12]

B. Tariffs

To construct the *output* tariffs, we map HS 9-digit tariffs from the Indonesia Industry and Trade Department into production data at the 5-digit ISIC level from the BPS based on an unpublished concordance.[13] Our 5-digit output tariff, then, is the simple average of the tariffs in the HS 9-digit codes within each 5-digit industry code.[14]

To compute a 5-digit *input* tariff, we use an input-cost weighted average of these 5-digit *output* tariffs, where

$$input\ tariff_t^{\,i} = \sum_j w_{1998}^{ij} * output\ tariff_t^{\,j}$$

(15)

$$\text{and} \qquad w_{1998}^{ij} = \frac{\sum_f input_{f,1998}^{ij}}{\sum_{f,j} input_{f,1998}^{ij}} .$$

The weights, w_{1998}^{ij}, are computed by aggregating the firm-level 1998 input data within 5 digit industry categories to create a 290 manufacturing input/output table. Thus, if industry *i* incurs 70 percent of its cost in steel and 30 percent in rubber, we give a 70 percent weight to the steel tariff and a 30 percent weight to the rubber tariff. We assume that the distribution of spending across inputs by industry is constant over our sample period, effectively assuming a Cobb-Douglas technology.

Importantly, these input tariffs are constructed at the industry level and not at the firm level. Further, the cost shares are based on total input purchases, both domestic and imported. If the weights only included a firm's own input choices or only imported

[12] These patterns are quite consistent with those in other countries. For example, Bernard et al. (2007) find that there is an exporter premium in US manufacturing equal to 6 percent for wages, 100 percent for employment, and 11 percent for TFP (see Table 3).

[13] These tariffs are from Mary Amiti and Jozef Konings (2007). This concordance was incomplete, so a large portion was manually concorded by the authors based on product descriptions. In some cases, it was not straightforward to map from the 9-digit tariff data to a single 5-digit industry. In order to avoid misplacement, we combined the 5-digit industries and computed a single output tariff. For example, it was difficult to separate rice milling from other grain milling products so these two industries were grouped together. For eight 5-digit ISIC industries there were no HS codes that could be assigned, for example industries that involved "cleaning and peeling of coffee or cocoa". Thus these were dropped from the sample. This leaves us with 226 distinct 5-digit output tariffs. This notwithstanding, the fact that firms in each industry have their own sets of input weights, per the constructed I-O table, allows us to construct a complete set of input tariffs for all 290 5-digit industries.

[14] We also present results with import-weighted average tariffs as a robustness check.

inputs, this would introduce an endogeneity bias.[15] Conditional on these concerns, we assign to each industry the most relevant input tariff. Thus, if an industry is intensive in rubber usage, the relevant tariff is that on rubber irrespective of whether the rubber is imported. There may be concern that the weights are based on a year during the Asian crisis. To address this, we also construct input tariffs using cost shares from the 1995 input/output table, but these are at a more aggregate level.

There is considerable variation in both input tariffs and output tariffs, as shown in Figures 4 and 5, where we plot 5-digit industry tariffs in 1991. In general, output tariffs are higher than input tariffs. Some 5-digit output tariffs were as high as 80 percent in the motorcycles and motor vehicle industries, while the highest input tariff was 36 percent in the footwear industry in 1991. Plotting the level of input tariffs against the level of output tariffs in Figure 6 depicts the differences in the two tariffs that industries faced in 1991. The correlation between output tariffs and input tariffs in 1991 is only 0.41.[16]

The highly detailed nature of the tariff data is also critical. As an example, the 3-digit transport equipment industry (ISIC 384) comprises ten 5-digit ISIC codes, where the output tariffs within this grouping ranged from 77 percent on motor vehicles and 32 percent for motor vehicle components to only 3 percent on railroad equipment in 1991. Prior studies often rely on the more aggregate 3-digit industry-level tariffs, which mask this heterogeneity.

Both input and output tariffs follow a downward trend over the sample period, although the largest reductions took place after 1995. The changes in input tariffs are plotted against changes in the output tariffs over the sample period in Figure 7. We see that large reductions took place in most tariffs, with only 4 industries (in the rice milling and liquor industries) experiencing an increase in output tariffs. Figure 7 also depicts the independent movements between changes in the two types of tariffs, with a correlation between the changes in input tariffs and output tariffs at 0.38. It is this independent

[15] It is possible to construct firm-level input tariffs only for those firms that exist in 1998, but this would cause problems relating to sample selection bias and introduce an endogeneity problem. For example, if importers are able to access cheaper inputs, their weighted tariff might appear lower than firms that purchase domestic inputs, providing a positive correlation between importers and profitability and hence wages. To avoid this potential pitfall, all tariffs are constructed at the industry level.

[16] Over the whole period, the correlation is equal to 0.46. Note that this is the correlation at the industry level. However, once the tariff data has been merged with the firm data, the correlation increases to 0.67, since the each industry tariff is repeated for every firm in that industry.

variation which helps to identify separate effects of the two tariff types on wages over this period.

4. Estimation

The model generates a number of hypotheses on how tariff cuts will affect wages. In particular, the effect of reducing output tariffs has differential effects on exporters and non-exporters, and the effect of reducing input tariffs has differential effects on importers and non-importers. To test these predictions, we estimate the following reduced form equation using OLS with firm fixed effects, α_f, to control for unobserved firm-level heterogeneity and interactive island-year and Jakarta-year fixed effects, $\alpha_{l,t}$, to control for shocks over time that affect wages across all sectors but which may vary across different parts of Indonesia.[17]

$$\begin{aligned}(16)\quad \ln(wage)^i_{f,t} &= \alpha_f + \alpha_{l,t} + \beta_1 * output\ tariff^i_t + \beta_2 * output\ tariff^i_t * FX^i_{f,t} + \\ &+ \beta_3 * input\ tariff^i_t + \beta_4 * input\ tariff^i_t * FM^i_{f,t} + Z^i_{f,t}\Gamma + \varepsilon^i_{f,t}.\end{aligned}$$

The dependent variable is the log of the average firm-level wage, defined as the total wage bill divided by the number of workers.[18] The key variables of interest are the 5-digit industry-level *output tariff* and the 5-digit industry-level *input tariff*. To allow for the differential effects of tariff cuts on wages predicted by the model, we interact output tariffs with an export dummy, *FX*=1, for firms that export any of their output. And we interact the input tariff with an import dummy, *FM*=1, for firms that import any of their intermediate inputs.

We hypothesize that a fall in output tariffs reduces wages of non-exporters, $\beta_1 > 0$, and will increase wages of exporting firms, $\beta_2 < 0$. The coefficient on the interactive term gives the differential effect between exporters and other firms. Thus the net effect for exporters is equal to $\beta_1 + \beta_2$. Recall that the theory predicts that some marginal firms that switch from domestic orientation to exporting following tariff cuts will experience a loss in profits and hence lower wages. These marginal firms will need to export a sufficiently large share of their output for the benefits of exporting to outweigh the loss in profits due

[17] There are five island dummies: Sumatra, Java, Kalimantan, Sulawesi, and the outer islands.
[18] We exclude overtime and bonus payments from the total wage bill so that variations in average wages reflect changes in the standard hourly wages rather than changes in the hours worked. As a robustness check, we include all of the wage components.

to increased import competition. To capture this effect, we interact output tariffs with the export share rather than an export dummy in some of the specifications, enabling us to calculate the critical export share that makes $\beta_1 + \beta_2 * \textit{export share}$ negative, indicating a rise in wages following tariff cuts.

Similarly, the theory predicts that a cut in input tariffs reduces wages of non-importers, $\beta_3 > 0$, and increases wages of sufficiently large importers, $\beta_4 < 0$, with the net effect on importers equal to $\beta_3 + \beta_4$. Again, marginal firms that switch from domestic orientation to importing following tariff cuts may experience a loss in profits and lower wages if the gains from importing do not outweigh the loss due to heightened competition with importing firms that experience a cut in their input costs. We expect that $\beta_3 + \beta_4 * \textit{import share}$ is negative for firms that import a sufficiently large share of inputs, indicating a rise in their wages following tariff cuts.

The vector $Z^i_{f,t}$ includes a firm's export orientation and import orientation. In some robustness specifications, we will include additional firm-specific characteristics. These will include ownership variables such as foreign ownership (the share of capital owned by foreigners) and government ownership (the share of capital owned by local or central government), skill share (the ratio of non-production workers to total employment) and the firm size (the number of employees).

5. Results

We estimate equation (16), first as an unbalanced panel with plant fixed effects for the period 1991 to 2000, and then in 5-period differences. All equations include island-year fixed effects and Jakarta-year fixed effects. The errors have been clustered at the industry/year level.[19]

A. Tariff cuts and Wages

The data support the model's predictions. To highlight the importance of the differential qualitative effects predicted for exporters and non-exporters, first we regress the log of average firm wage only on output tariffs and find a positive significant

[19] We cluster the errors at the industry/year level to take account of the tariffs being at the industry level and the dependent variable at the plant level (Brent R. Moulton, 1990). Alternatively, we could cluster at the plant level to take account of heteroskedasticity. The plant-level clustering produces the same conclusions, with smaller standard errors.

coefficient in column 1 of Table 2, suggesting that cuts in output tariffs reduce wages.[20] When we interact the output tariff with the export dummy in column 2, we find that the coefficient on output tariffs remains positive and significant, and its magnitude increases, but now we see that the coefficient on the output tariff interacted with exporter status is negative and significant. Thus the wage in non-exporting firms *falls* following cuts in output tariffs, and the wage in exporting firms *increases*, since $\beta_1 + \beta_2 < 0$.

Next, we consider the effects of reducing input tariffs. When we include the input tariff on its own (column 3 of Table 2), we see that it has an insignificant effect on firm-level wages. Yet, when we interact input tariffs with an import dummy in column 4, the coefficient on this interaction term is negative and significant, indicating that a cut in input tariffs leads to higher wages for importing firms, as predicted by our model. However, the coefficient on *input tariffs* remains insignificant in column 4, indicating that non-importers are unaffected by cuts in input tariffs. This contrasts with the model's prediction that non-importers become less profitable following a cut in input tariffs because of the relative advantage importers derive from access to a greater variety of inputs. Of course, there are other possible offsetting effects beyond the purview of the present model that might explain the insignificant coefficient. For example, sharper competition from imports following a cut in tariffs might force domestic intermediate producers to cut prices. This would then also reduce the costs for firms that purchase their inputs domestically.

The same conclusions emerge when we include both input and output tariffs in the same specification in column 5, with the magnitudes and significance levels almost identical to the specification where the input and output tariffs were included individually. This is reassuring, as it indicates there is sufficient variation in each tariff type to enable us to disentangle the two effects.

To determine the critical share of exports necessary for a firm to experience increasing wages following lower output tariffs, we reestimate equation (16) with share variables in column 6 to measure a firm's global orientation (instead of the dummy variables to indicate export and import participation in column 5). The results in column 6 indicate that a firm that exports more than 28 percent of its output experiences a wage

[20] This is consistent with Revenga (1997), which finds that a fall in output tariffs reduced wages in Mexico.

rise following a cut in output tariffs.[21] To calculate the average effect of wages on exporting firms, the coefficient on the interaction term must be multiplied by the average export share for exporters, which is equal to 0.7 (see Appendix Table A1). Similarly, the average effect of a cut in input tariffs on importers can be calculated by multiplying the coefficient on the interactive input tariff in column 6, equal to -0.8, with the mean import share for importers equal to 0.42 (see Appendix Table A1), indicating an average effect of around 0.4, which is very close to the result in column 5 with the dummy variables.

The model also predicts synergistic effects for importers and exporters, which should give rise to larger wage impacts for those firms. To isolate these effects, we split globalized firms into those that only export, *FXX=1*, those that export and import, *FMX=1*, and those that only import, *FMM=1*. Consistent with the model, in column 7 we see that a reduction in output tariffs increases the wages for all exporters, with the magnitude larger for firms that import and export than for firms that only export. Similarly, a reduction in input tariffs increases wages for all importers, with the magnitude higher for firms that import and export compared with those firms that only import. Estimating these effects using export and import shares rather than dummy indicators (column 8) produces the same conclusions.[22]

These results highlight the importance of firm heterogeneity in the choice of mode of globalization. If as in prior work we neglect export status we would be able to identify only the average effect of changes in output tariffs on wages rather than the distinct and opposite effects we actually find in the data. Past research has neglected entirely the examination of input tariffs, which we remedy here. Moreover, it is again crucial to separate firms that import intermediates to see that there is a differential effect on wages of tariff cuts on inputs for workers at firms that import. The heterogeneous firm model provides a path from tariff cuts to profit gains for sufficiently large exporters and sufficiently large importers, while our hypothesis that firm wages are increasing in firm profits then links this to wages at the firm.

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[21] This critical value is calculated as $\beta_1/-\beta_2$=0.09/-0.22.

[22] As a robustness check, we re-estimated all of the specifications in Table 2 redefining the dependent variable to include overtime and bonus payments. All of the conclusions remain unchanged, with the magnitudes of the coefficients on tariffs slightly larger.

B. Robustness

B.1. Additional controls

All of the specifications in Table 2 include firm fixed effects plus indicators of changes in import and exporter status but we want to examine whether additional time varying firm-level controls might change the results. They do not. In column 1 of Table 3A, we include dummy indicators of foreign ownership and government ownership and we see that the coefficients are positive and significant. In order to be certain that the coefficients on tariff changes are not driven by the foreign firms in the sample, column 2 excludes all foreign firms. The results are unchanged.

An additional potential concern is the role of firm differences in skill composition. We include firm fixed effects, so that unchanging differences in skill composition will not affect the results. However, this leaves open the possibility that the results are driven by changes in the skill composition of the firms' work force. For example, if firms respond to changes in tariffs by upgrading the quality of their workforce, this could bias the coefficients on tariffs. To check that the change in the skill composition is not biasing the coefficients on the tariff variables, we include the firm-level skill share in column 3 of Table 3A. We see that the coefficient on skill share is positive and significant, thus firms that employ relatively more skilled workers do indeed on average pay higher wages. But, more importantly, the inclusion of the skill share leaves the coefficients on tariffs unchanged.

Including the number of workers at the firm level in column 4 also leaves the results unaffected. Wages are known to vary with the size of firms, so it is important to control for this in case the size of the firm is correlated with tariffs. Increases in overall employment have a negative effect on the average wage bill. Given that the dependent variable is calculated as the ratio of the total wage bill to the number of employees, this indicates that the total wage bill is less responsive than changes in employment.

We control for exiting firms in column 5 and show that this too has no effect on our main results. The exit dummy variable equals one the year before the firm exits. The coefficient on the exit indicator shows that on average firms that shortly will exit pay 5 percent lower wages, which is consistent with our model where the least efficient and lower paying firms end up exiting.

Finally, we want to be sure that these robustness results do not depend on our use of dummy indicators for globalization. Hence (in parallel to the corresponding column from Table 2) column 6 of Table 3A adds trade shares in place of the dummies. Again, the substantive results are unaffected.

B.2. Asian Crisis

Our sample period includes the Asian crisis of 1997 and 1998, during which time Indonesia experienced large depreciations, high inflation and a banking crisis. To ensure that our results are not being driven by this crisis period, we re-estimate equation (16) for the pre-crisis period 1991 to 1996 in column 1 of Table 3B and see that the coefficients are similar to those for the full sample.

Another potential influence of the Asian crisis on our results arises from constructing input tariffs with industry cost shares based on firm-level data in 1998, the only year such detailed data are available. If cost shares differed during the crisis years from other years this would affect the input tariff variable and could affect our results. To address this issue, we recalculate the input tariffs using 1995 weights from input/output tables in equation (15) instead of the 1998 weights. The disadvantage of using these 1995 weights is that the input tariffs are far more aggregated than our central measures. The 1995 weights from the input/output table only enable us to construct input tariffs when the 290 industries are grouped into a more aggregated set of 90 industries. As we showed in section 3B there is tremendous heterogeneity of input tariffs across 5-digit industries, thus aggregation is a serious concern.

We see from column 2 in Table 3B, where we include the 1995 weighted input tariffs, that the signs of the coefficients are the same as before but the size of the coefficient on input tariffs interacted with importers falls by about half. However, this is not compelling evidence that the Asian crisis mattered for our calculations. Rather it seems that this may be the result of aggregation biases. We show this in column 3 of Table 3B, where we use the same level of aggregation as the 1995 input/output tables with the1998 data. We see that the coefficients in columns 2 and 3 are very similar. This strongly suggests that the differences are driven, not by the Asian crisis, but by aggregation.

B.3. Alternative Tariffs

An additional robustness check concerns the choice of weights in constructing the 5-digit industry tariffs from the underlying HS 9-digit tariff data. A central choice is whether to use import weights or a simple average. The main disadvantage of using import weights is that very high tariffs receive low weights when there are low import values within those categories. Further, changing import weights each year results in variations in the year-to-year average tariff levels even if the tariffs have remained the same. One solution to this is to fix the weights either at the beginning or at the end of the period or as an average of the base and current year to construct a Fisher ideal index. But fixing weights could result in an average import weighted tariff appearing as a zero for some industries each year even though there might be a positive tariff and positive trade in some years. To avoid the problems associated with import weights, we use simple averages in our main estimations but we present estimates of the effect of import weighted tariff cuts on wages using the Fisher index, as a robustness check in column 4 of Table 3B.[23] These results are similar to those with simple average tariffs except that the size of the coefficients on the output tariff and the output tariff interacted with exporters in column 6 are a bit smaller.

Another potential concern arises due to Indonesia operating duty-free zones, which allows firms to import inputs without paying any tariffs if their output is for export. If a firm was already able to import duty free inputs, then cuts in input tariffs should not be of benefit to them and in fact could hinder their performance due to the competition effect of other firms being able to access lower-cost imported inputs. To ensure that this does not bias our coefficients we interact input tariffs with a free-trade indicator equal to one if a firm is located in a duty-free zone in column 5 of Table 3B. Inclusion of this interaction term does not affect the coefficient on *input tariff* x *FM*, but the results show that firms located in the duty-free zone actually get an additional boost, with the coefficient on *input tariff* x *FM* x *free trade* equal to -0.34, which is jointly significant. This implies that a 10 percentage point fall in the input tariff increases wages of importing firms in the free trade zones by an additional 3.4 percent compared with

[23] The results are the same using 1991 or 2000 weights. We were unable to get imports at the HS 9-digit level, so the import-weighted 5-digit ISIC tariffs are constructed by first taking the simple mean of the HS 9-digit to HS 6-digit, then weighting the HS 6-digit tariffs by the import shares.

importing firms not in the free trade zone. This is not what we might have expected. It is possible that other costs of accessing duty-free inputs may have also fallen. Whatever the correct story, it is reassuring that taking the free trade zones into account does not alter our main results.

C. Alternative Econometric Specifications

Up to this point all the estimations have been in levels with firm fixed effects. We now turn to estimations with all variables in 5-period differences. We continue to control for island-year and Jakarta-year fixed effects.

C.1. Long Differences - OLS

Estimating equation (16) in 5-period differences produces the same conclusions as the levels equations with firm fixed effects. The results in Table 4 show that the signs and significance levels of all the coefficients on the tariff variables are the same as the levels equations in Tables 2 and 3, and the magnitude of the coefficients is larger (compare columns 5 and 6 in Table 4 with columns 5 and 6 in Table 3A). The long differencing helps wash out measurement error and any concern of unit roots that may be prevalent in the levels equations.

C.2. Long Differences –Instrumental Variables

In order to identify the effects of tariff reductions on wages, an important question is whether the trade reform pattern is endogenous, as this would lead to biased estimates. It could be argued that firms in low wage growth industries lobby for protection, which would lead to reverse causality and a negative bias on the output tariff coefficient.[24] In panel estimation, the potential bias due to endogeneity of tariffs is reduced because all the estimates include firm fixed effects, so if political economy factors are time invariant, this is already accounted for (see Goldberg and Pavcnik, 2005). However, time varying industry characteristics could simultaneously influence wages and tariffs. To address this,

[24] The political economy literature argues that certain industries have more political power to lobby governments for protection (see Grossman and Helpman, 1994). Interestingly, Ahmed M. Mobarak and Denni Purbasari (2005) find that political connections in Indonesia do not affect tariff rates.

Trefler (2004) proposes using initial industry-level characteristics as instruments in a differenced equation.[25] We follow his approach.

Hence we also use two-stage least squares and these are the central results reported in our paper. The IV estimates in column 7 of Table 4 are for the 5-period differenced model, as it is easier to find instruments for changes in tariffs rather than for levels. Following Trefler, the instrument set includes initial industry-level characteristics, as these are unlikely to be correlated with the 5-period differenced residuals. In addition, the instruments must be correlated with tariff changes. For output tariffs, likely candidates include the 1991 share of production workers in total industry employment to reflect an industry's propensity to get organized, and this variable interacted with the 5-period lagged export status dummy indicator. We add an exclusion dummy which equals one if a 5-digit industry contained 10 or more HS 9-digit products that were excluded from Indonesia's WTO commitment to reduce all bound tariffs to 40 percent or less; and we include a non-tariff barrier dummy.[26]

The political economy of reducing output tariffs may differ from that of reducing input tariffs. For example, car workers may have lobbying power to reduce tariffs on motor vehicles but limited power to affect tariffs on intermediate inputs like steel. Thus, for input tariffs we include the 1991 input tariff level and its interaction with the 5-period lagged import status indicator. The instruments provide a good fit in the first stage,[27] and pass the overidentifiction tests with a *p*-value equal to 0.17.

Comparing the IV results in column 7 with the OLS results in column 6, we see that the magnitude of the IV coefficients is higher. A 10 percentage point cut in output tariffs reduces wages in import-competing firms by 3 percent. Firms that export at least 50 percent of their output experience a wage increase following tariff cuts, with a 3

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[25] Trefler notes that endogeneity is rejected in every one of his plant-level specifications and the instrumental variables approach is only relevant for his industry-level specifications.

[26] The WTO commitment was made at the beginning of 1995 to reduce bound tariffs over a 10 year period. The tariff lines are at the HS 9-digit level, comprising thousands of product codes. For the exclusion list, see http://www.wto.org/english/tratop_e/schedules_e/goods_schedules_e.htm. There were nine industries which contained 10 or more excluded HS 9-digit codes. The industries with the highest number of exclusions were motor vehicles and components, and iron and steel basic industries. For the non-tariff barrier dummy, there were 36 5-digit industries that contained 10 or more HS 9-digit codes subject to non-tariff barriers.

[27] Because the IV specification includes more than one endogenous variable, we include the Cragg-Donald statistic, with a χ^2 distribution to check for weak instruments. The Cragg-Donald statistic is well above the critical values listed in Table 1 of James H. Stock and Motohiro Yogo (2005).

percent wage increase in firms that export all their output. A 10 percentage point cut in input tariffs increases wages by 12 percent for workers employed by importing firms.

D. Discussion of Results

Given that all our estimates include year fixed effects, these will capture an average effect of trade liberalization on wages. We cannot say what the total effect of trade liberalization is on wages because we cannot separately identify the role of tariff cuts on the year effects. The results do show that, relative to the average, exporters and importers pay higher wages following tariff cuts and domestic oriented firms pay lower wages. This can be seen clearly from Figure 8 where we plot the firm's predicted change in wage as a function of its import share and export share. We calculate the firm's fitted wage, resulting from the change in tariffs over the whole sample period, for all firms in the sample in 2000 as follows:

$$\Delta\hat{w}_f = \beta_1 * \Delta output\ tariff_i + \beta_2 * \Delta output\ tariff_i * export\ share_f \\ + \beta_3 * \Delta input\ tariff + \beta_4 * \Delta input\ tariff_i * import\ share_f$$

We see from Figure 8 that firms with negative predicted wages are those that are predominantly domestic oriented (close to the origin), and those with the large positive predicted wages are the industries that are large globalizers either with a high export share or a high import share (away from the origin). There is large heterogeneity in firm-level wage responses. For example, in the motor vehicle industry, which experienced one of the biggest declines in output tariffs of 45 percentage points, the fitted wage change for firms that sell all their output in the domestic market and buy all their inputs locally is a fall of 15 percent. Yet, within the same industry, firms that export large shares of their output and import their inputs have a positive fitted wage change of 4 percent. The largest predicted wage gains following tariff cuts were 29 percent in the toy industry, which experienced big cuts in both input and output tariffs, and these were for firms that export all of their output and import all of their inputs.

6. Conclusions

The effect of trade liberalization on wages has generated a vast literature in international economics. Yet no prior study has simultaneously accounted for the two most salient empirical facts about international production to emerge in the last decade.

The first fact is firm heterogeneity – that larger firms are more productive, more likely to export and import, and pay higher wages. The second fact is the prominent role of intermediate trade, distinct from final goods trade. Firm heterogeneity is the very foundation of our approach to firm-level wages. And theory tells us that reductions in final and intermediate goods tariffs tend to have opposite signs, so distinguishing their impacts is crucial. We incorporate both salient facts in our analysis.

Our theory combines elements of Melitz (2003) and Kasahara and Lapham (2007) with a novel specification of firm wage setting in the tradition of Akerlof and Yellen (1990) fair wages. This allows us to develop a general equilibrium model with firm heterogeneity, trade in final and intermediate goods, and firm-specific wages. The model predicts that the wage consequences of liberalization vary qualitatively and quantitatively with the nature and magnitude of firms' global engagement via exports and imports.

We examine the predictions of the model with highly detailed firm-level data for the Indonesian trade liberalization in the period 1991-2000. Of particular note is that our data allow us to construct highly detailed import tariffs on inputs, hence to separate the effects of cuts in input tariffs from cuts in output tariffs.

The results are strongly supportive of the predictions arising from the theory and stable across a wide variety of robustness checks. Introducing firm heterogeneity and a separate impact for input and output tariffs (and their interactions) is crucial to the results. Cuts in output tariffs reduce wages at firms oriented exclusively to the domestic market, but raise wages at firms that export a sufficient share of their output. Cuts in input tariffs raise wages at firms that import inputs while having no effect on wages of workers at firms that fail to import. And there is a synergy in these effects, so that the largest impact of liberalization in raising wages is at firms most globally engaged in both exports and imports.

References

Akerlof, George A., 1982. "Labor Contracts as Partial Gift Exchange," *Quarterly Journal of Economics*, 97(4): 543-569.

Akerlof, George A., and Janet L. Yellen. 1990. "The Fair Wage-Effort Hypothesis and Unemployment." *Quarterly Journal of Economics*, 105(2): 255-83.

Amiti, Mary, and Jozef Konings. 2007. "Trade Liberalization, Intermediate Inputs and Productivity." *American Economic Review*, 97(5): 1611-38.

Arai, Mahmood. 2003. "Wages, Profits, and Capital Intensity: Evidence from Matched Worker-Firm Data." *Journal of Labor Economics*, 21(3): 593-613.

Bernard, Andrew B., Brad Jensen, Stephen J. Redding, and Peter K. Schott. 2007. "Firms in International Trade." *Journal of Economic Perspectives*, 21(3): 105-30.

Davis, Donald R., and James Harrigan. 2007. "Good Jobs, Bad Jobs, and Trade Liberalization." NBER Working Paper 13139.

Eaton, Jonathan, Samuel S. Kortum, and Francis Kramarz. 2004. "An Anatomy of International Trade: Evidence from French Firms." http://www.econ.nyu.edu/user/eatonj/EKK5.pdf.

Egger, Hartmut, and Udo Kreickemeier. 2006. "Firm Heterogeneity and the Labour Market Effects of Trade Liberalization." GEP Research Paper 2006/26.

Feenstra, Robert C., and Gordon H. Hanson. 1999. "The Impact of Outsourcing and High-Technology Capital on Wages: Estimates for the United States, 1979-1990." *Quarterly Journal of Economics*, 114(3): 907-40.

Feenstra, Robert C., and Gordon H. Hanson. 2003. "Global Production Sharing and Rising Inequality: A Survey of Trade and Wages." In *Handbook of International Trade*, ed. E. Kwan Choi and James Harrigan, 146-85. London: Basil Blackwell.

Felbermayr, Gabriel J., Julien Prat, and Hans-Jorg Schmerer. 2008. "Globalization and Labour Market Outcomes: Wage Bargaining, Search Frictions, and Firm Heterogeneity." IZA Discussion Paper 3363.

Goldberg, Pinelopi K., and Nina Pavcnik. 2005. "Trade, Wages, and the Political Economy of Trade Protection: Evidence from the Colombian Trade Reforms." *Journal of International Economics*, 66(1): 75-105.

Goldberg, Pinelopi K., and Nina Pavcnik. 2007. "Distributional Effects of Globalization in Developing Countries." *Journal of Economic Literature*, 45(1): 39-82.

Grossman, Gene M., and Elhanan Helpman. 2007. "Fair Wages and Foreign Sourcing." Weatherhead Center for International Affairs, Working Paper 2008-0045.

Harrison, Ann E., ed. 2007. *Globalization and Poverty*, Chicago: University of Chicago Press.

Helpman, Elhanan,and Oleg Itskhoki. 2007. "Labour Market Rigidities, Trade and Unemployment." NBER Working Paper 13365.

Kahneman, Daniel, Jack L. Knetsch, and Richard Thaler. 1986. "Fairness as a Constraint on Profit Seeking: Entitlements in the Market." *American Economic Review*, 76(4): 728-41.

Kasahara, Hiroyuki, and Beverly J. Lapham. 2007. "Productivity and the Decision to Import and Export: Theory and Evidence." CESifo Working Paper 2240.

Levine, David I., 1993. "Fairness, Markets, and Ability to Pay: Evidence from Compensation Executives," *American Economic Review*, Vol. 83, No. 5, pp. 1241-1259.

Melitz, Marc J. 2003. "The Impact of Trade on Intra-Industry Reallocations and Aggregate Industry Productivity." *Econometrica*, 71(6): 1695-1725.

Mobarak, Ahmed M., and Denni Purbasari. 2005. "Political Trade Protection in Developing Countries: Firm Level Evidence from Indonesia." http://ssrn.com/abstract=770949.

Moulton, Brent R. 1990. "An Illustration of a Pitfall in Estimating the Effects of Aggregate Variables on Micro Units." *Review of Economics and Statistics*, 72(2): 334-38.

Pavcnik, Nina, Andreas Blom, Pinelopi Goldberg, and Norbert Schady. 2004."Trade Policy and Industry Wage Structure: Evidence from Brazil." *World Bank Economic Review*, 18(3): 319-44.

Revenga, Ana. 1997. "Employment and Wage Effects of Trade Liberalization: The Case of Mexican Manufacturing." *Journal of Labor Economics*, 15(3): S20-S43.

Stock, James H. and Motohiro Yogo. 2005. "Testing for Weak Instruments in Linear IV Regression." in I*dentification and Inference for Econometric Models: Essays in Honor of Thomas J. Rothenberg*, ed. James H. Stock and Donald W. K. Andrews, 80-108. Cambridge and New York: Cambridge University Press.

Trefler, Daniel. 2004. "The Long and the Short of the Canada-US Free Trade Agreement." *American Economics Review*, 94(4): 870-895.

Verhoogen, Eric A. 2008. "Trade, Quality Upgrading and Wage Inequality in the Mexican Manufacturing Sector." *Quarterly Journal of Economics*, 123(2): 489-530.

Verhoogen, Eric A., Stephen V. Burks, and Jeffrey P. Carpenter. 2007. “Fairness and Freight-Handlers: Local Labor Market Conditions and Wage Fairness Perceptions in a Trucking Firm.” *Industrial and Labor Relations Review*, 60(4): 477-98.

Yeaple, Stephen R. 2005. “A Simple Model of Firm Heterogeneity, International Trade, and Wages.” *Journal of International Economics*, 65(1): 1-20.

Yi, Kei-Mu. 2003. “Can Vertical Specialization Explain the Growth of World Trade?” *Journal of Political Economy*, 111(1): 52-102.

Figure 1. ***Determination of firm wage and profit for given mode of globalization***

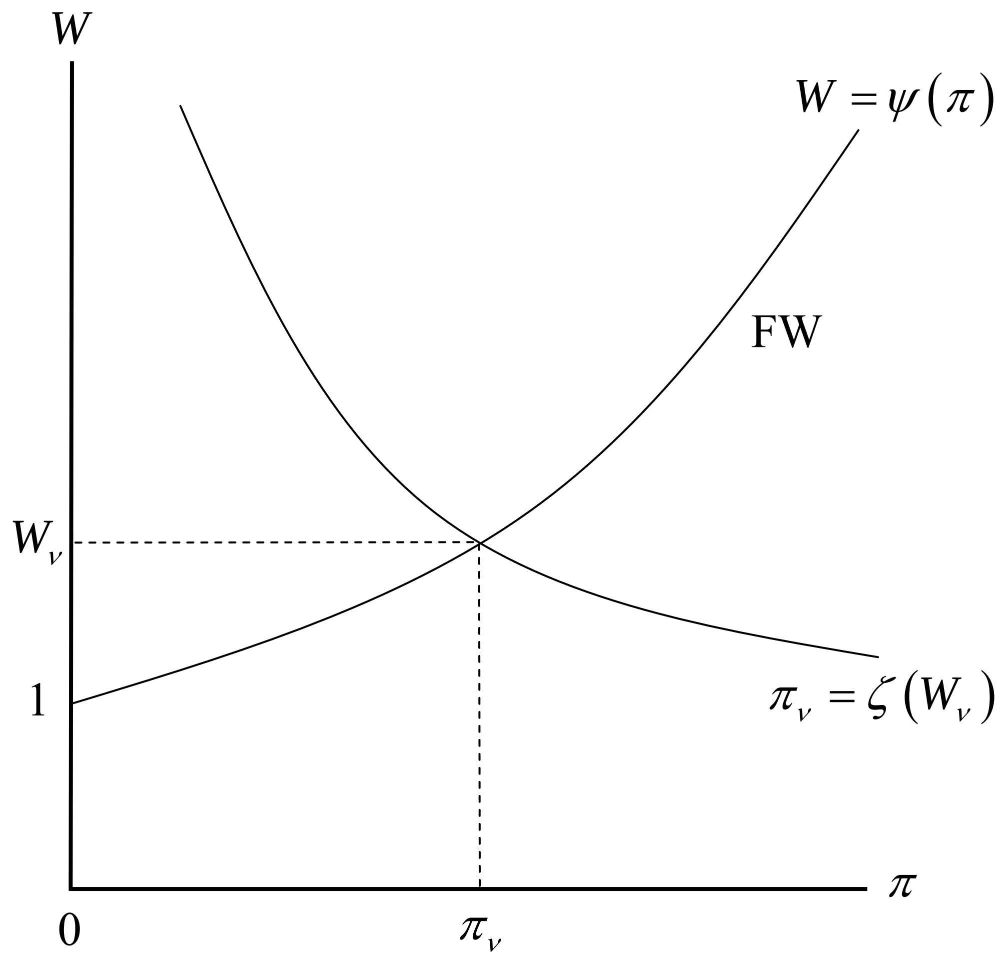
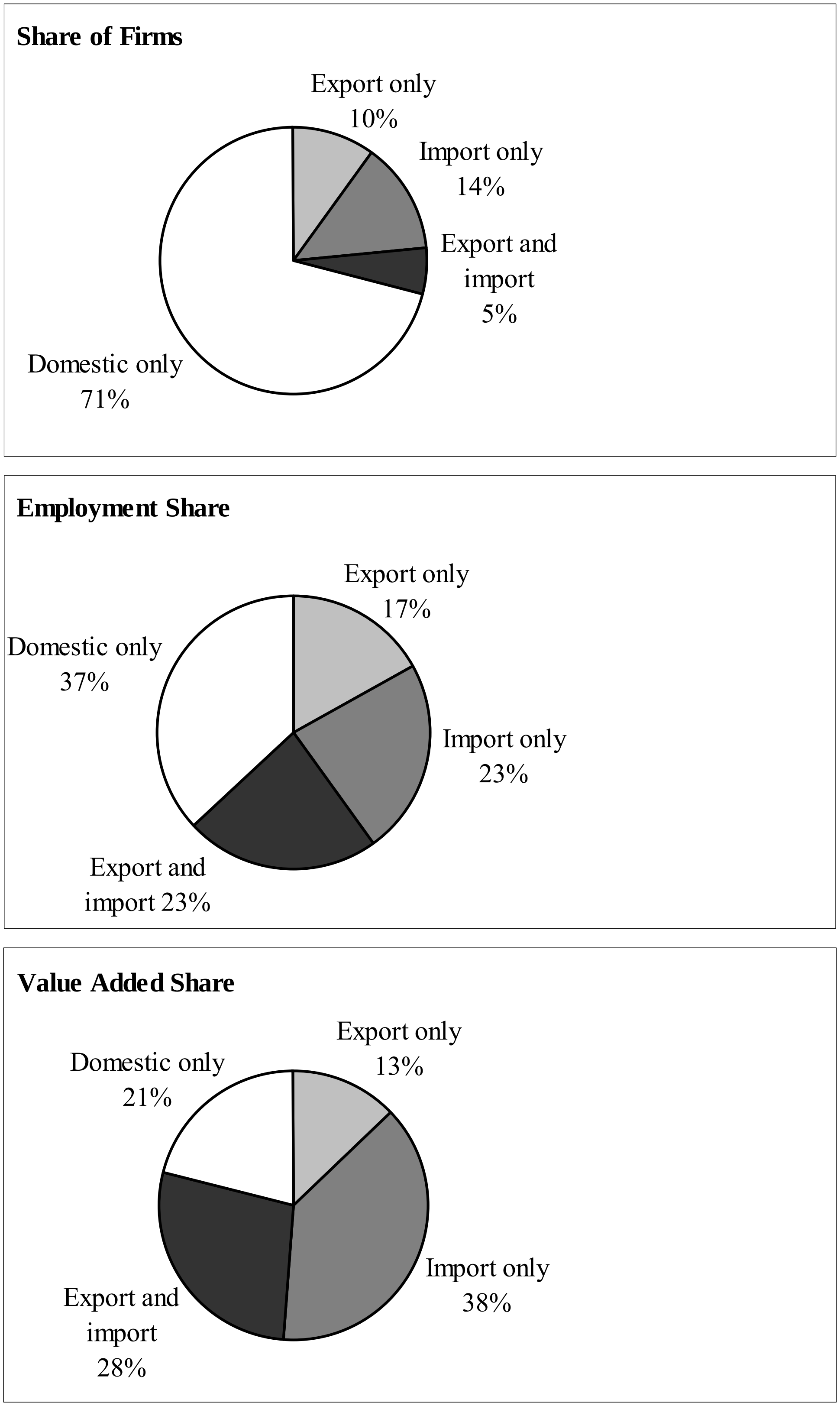


Figure 2. Firm Heterogeneity by Mode of Globalization



$N = 185{,}866$

Figure 3. Firm Level Wages Vary Greatly

Figure 4. Output Tariffs Vary Across Industries

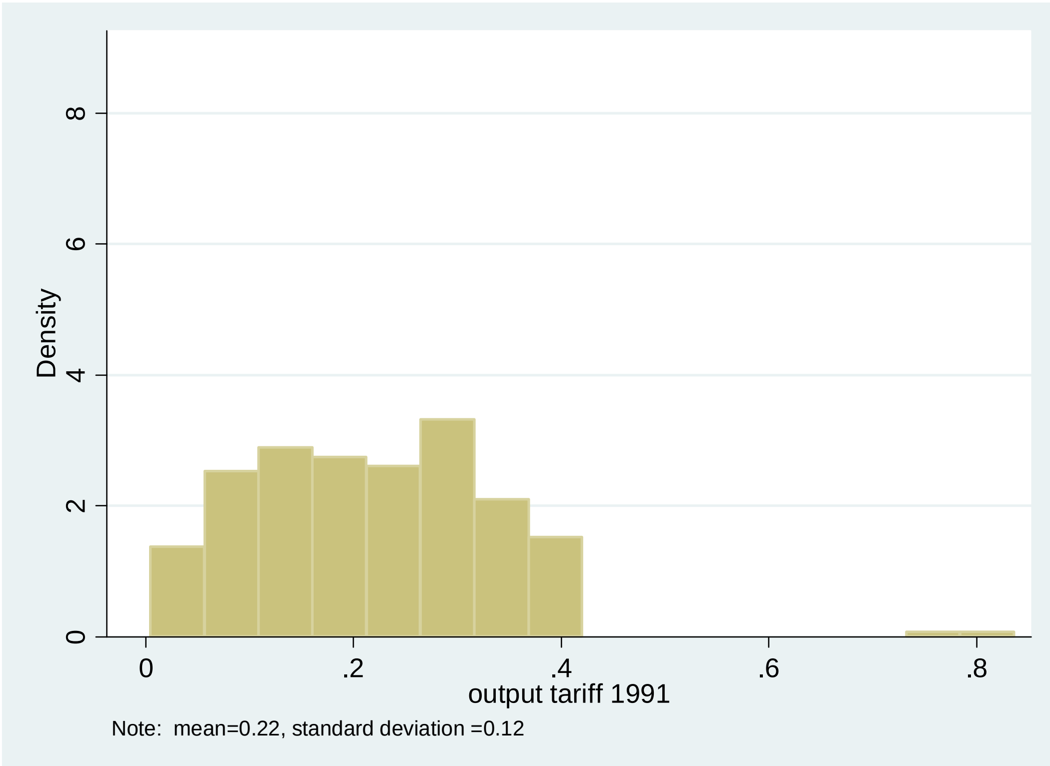


Figure 5. Input Tariffs Vary Across Industries

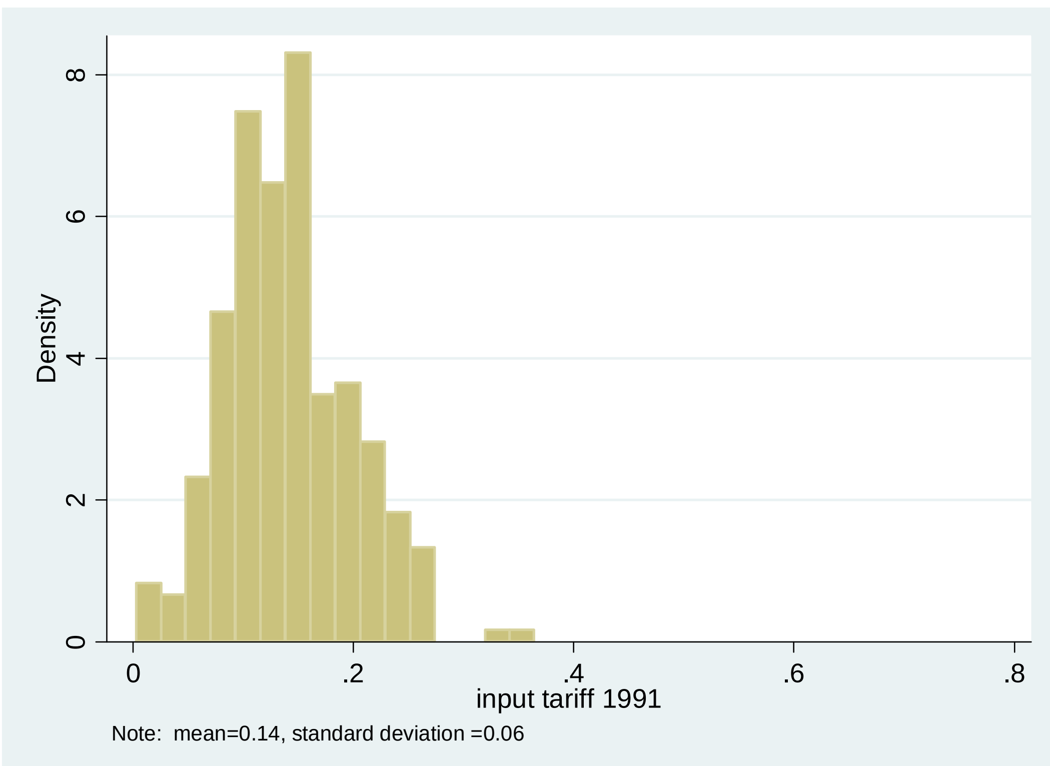


Figure 6. Tariff Levels on Inputs and Output are Weakly Correlated

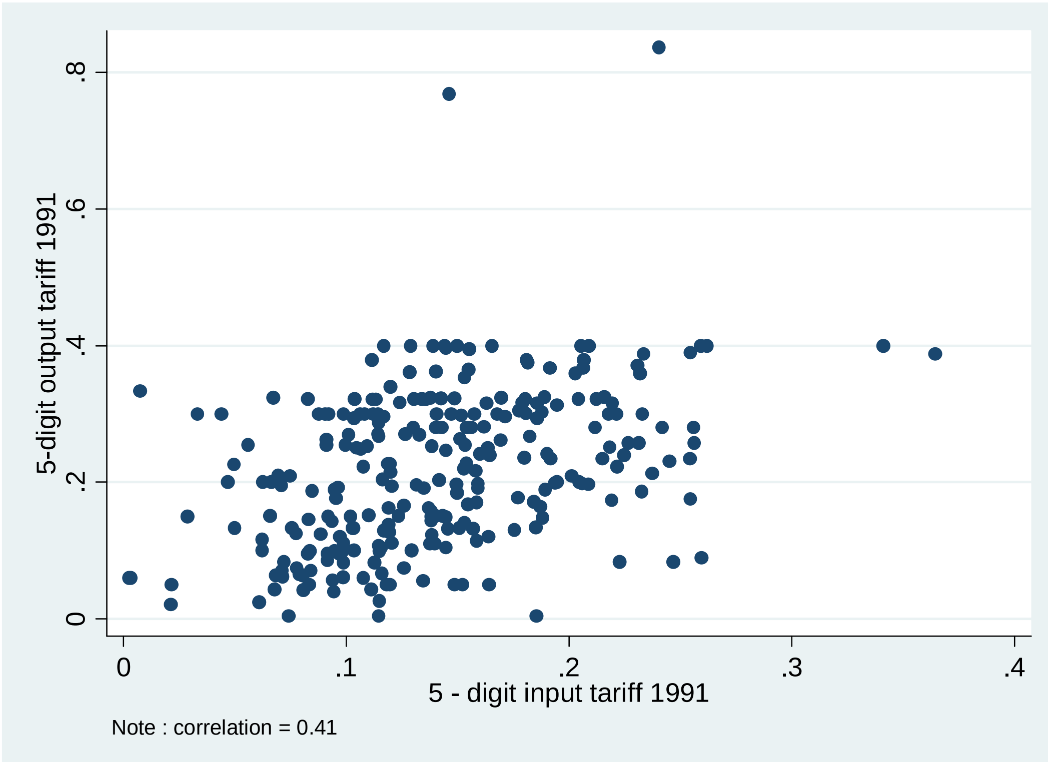


Figure 7. Changes of Input and Output Tariffs are Weakly Correlated

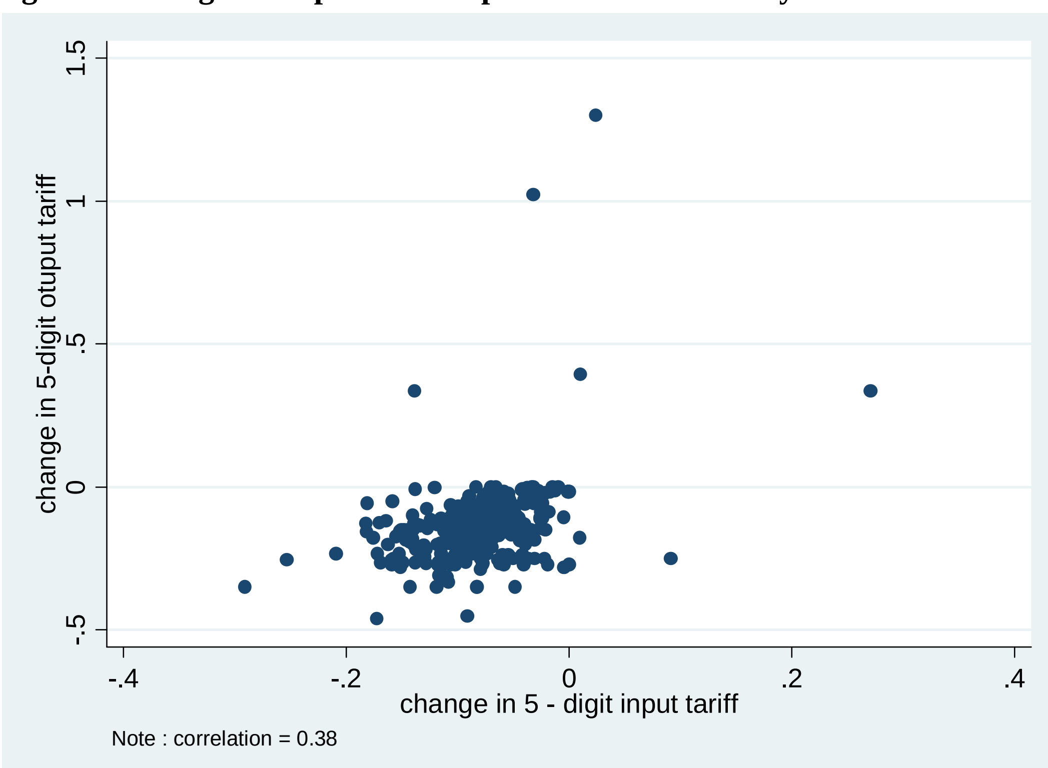
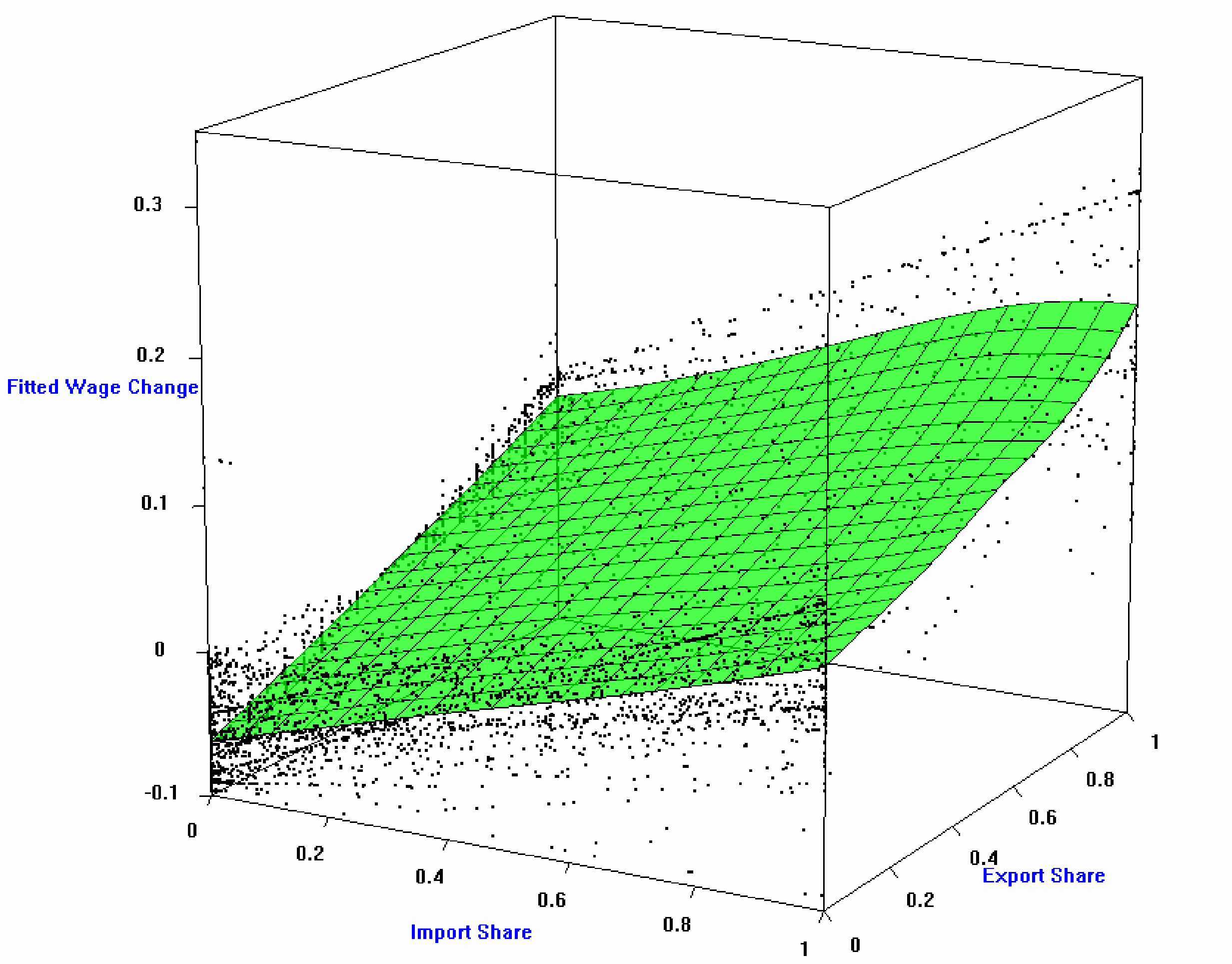


Figure 8. Modes of Globalization and Firm Wage Changes



The predominance of negative values near the origin indicates that non-globalizers lose from liberalization, and vice versa for those who globalize via exports or imports.

Table 1A: Importers, Exporters and Wages

Dependent Variable	$\ln(wage)^{i}_{f,t}$	$\ln(wage)^{i}_{f,t}$	$\ln(wage)^{i}_{f,t}$	$\ln(wage)^{i}_{f,t}$	$\ln(wage)^{i}_{f,t}$	$\ln(wage)^{i}_{f,t}$
	(1)	(2)	(3)	(4)	(5)	(6)
Exporters	0.275***	0.176***	0.251***	0.161***	0.133***	0.076***
	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)
Importers	0.468***	0.245***	0.381***	0.214***	0.287***	0.146***
	(0.005)	(0.005)	(0.004)	(0.004)	(0.004)	(0.004)
Importers and exporters	0.664***	0.445***	0.618***	0.422***	0.389***	0.254***
	(0.007)	(0.006)	(0.006)	(0.006)	(0.007)	(0.007)
skillshare			1.367***	0.897***	1.279***	0.833***
			(0.013)	(0.012)	(0.013)	(0.012)
ln(labor)					0.111***	0.097***
					(0.001)	(0.001)
year effects	yes	yes	yes	yes	yes	yes
industry effects	no	yes	no	yes	no	yes
Observations	185,866	185,866	185,866	185,866	185,866	185,866
R squared	0.30	0.52	0.37	0.54	0.39	0.55

Table 1B: Importers, Exporters and Size

Dependent Variable	$\ln(labor)^{i}_{f,t}$	$\ln(labor)^{i}_{f,t}$	$\ln(va)^{i}_{f,t}$	$\ln(va)^{i}_{f,t}$	$\ln(tfp)^{i}_{f,t}$	$\ln(tfp)^{i}_{f,t}$
	(1)	(2)	(3)	(4)	(5)	(6)
Exporters	1.074***	0.889***	1.604***	1.297***	0.120***	0.107***
	(0.009)	(0.009)	(0.014)	(0.014)	(0.005)	(0.005)
Importers	0.893***	0.731***	1.746***	1.261***	0.107***	0.116***
	(0.009)	(0.009)	(0.015)	(0.014)	(0.005)	(0.004)
Importers and exporters	2.085***	1.749***	3.318***	2.692***	0.203***	0.202***
	(0.013)	(0.012)	(0.018)	(0.018)	(0.008)	(0.006)
year effects	yes	yes	yes	yes	yes	yes
industry effects	no	yes	no	yes	no	yes
Observations	185,866	185,866	172,235	172,235	153,018	153,018
R squared	0.24	0.39	0.27	0.45	0.02	0.47

Robust standard errors in parentheses; * significant at 10%; ** significant at 5%; *** significant at 1%

Table 2: Tariffs and Wages

Dependent Variable: ln(wage) $^{i}_{f,t}$	Output tariff	With exporters	Input tariff	With importers	All	With trade shares	Separating firms that import & export: Dummies	Separating firms that import & export: Shares
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Output tariff$^{i}_{t}$	0.056*	0.084**			0.100**	0.094**	0.101**	0.095**
	(0.032)	(0.034)			(0.045)	(0.045)	(0.045)	(0.045)
Output tariff$^{i}_{t}$ x $FX_{f,t}$		-0.227***			-0.194***	-0.221***		
		(0.039)			(0.038)	(0.050)		
Output tariff$^{i}_{t}$ x $FXX_{f,t}$							-0.145***	-0.142**
							(0.045)	(0.055)
Output tariff$^{i}_{t}$ x $FMX_{f,t}$							-0.263***	-0.345***
							(0.070)	(0.082)
Input tariff$^{i}_{t}$			-0.025	0.033	-0.039	-0.049	-0.046	-0.053
			(0.054)	(0.057)	(0.084)	(0.082)	(0.085)	(0.083)
Input tariff$^{i}_{t}$ x $FM_{f,t}$				-0.504***	-0.444***	-0.772***		
				(0.078)	(0.077)	(0.152)		
Input tariff$^{i}_{t}$ x $FMM_{f,t}$							-0.376***	-0.604***
							(0.086)	(0.188)
Input tariff$^{i}_{t}$ x $FMX_{f,t}$							-0.462***	-0.929***
							(0.152)	(0.203)
$FX_{f,t}$=1 if export share >0	0.018***	0.058***	0.018***	0.019***	0.053***	0.056***		
	(0.005)	(0.008)	(0.005)	(0.005)	(0.008)	(0.011)		
$FXX_{f,t}$=1 if export share>0 & import share=0							0.041***	0.035***
							(0.010)	(0.013)
$FMX_{f,t}$=1 if export share>0 & import share>0							0.159***	0.079***
							(0.014)	(0.019)
$FM_{f,t}$=1 if import share>0	0.036***	0.036***	0.036***	0.093***	0.086***	0.135***		
	(0.005)	(0.005)	(0.005)	(0.010)	(0.010)	(0.019)		
$FMM_{f,t}$=1 if import share>0 & export share=0							0.076***	0.109***
							(0.011)	(0.022)
$FMX_{f,t}$=1 if import share>0 & export share>0 [28]								0.177***
								(0.027)
Observations	185,866	185,866	185,866	185,866	185,866	185,866	185,866	185,866
R-squared	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85

Robust standard errors in parentheses; * significant at 10%; ** significant at 5%; *** significant at 1%

[28] In column 7 export and import status are entered as dummies so there are only 3 groupings: those that only export, those that only import and those that export and import. In column 8, export and import status are entered as export and import shares so there are four groupings: export shares of firms that only export, export shares of firms that export and import; and import shares of firms that only import and import shares of firms that import and export.

Table 3A: Tariffs and Wages – Sensitivity

Dependent Variable: ln(wage) $^{i}_{f,t}$	Ownership (1)	Without foreign firms (2)	With skill share (3)	With size (4)	With exit (5)	With trade shares (6)
Output tariff $^{i}_{t}$	0.104**	0.118**	0.108**	0.107**	0.100**	0.094**
	(0.045)	(0.047)	(0.045)	(0.045)	(0.045)	(0.045)
Output tariff $^{i}_{t}$ x $FX_{f,t}$	-0.193***	-0.180***	-0.190***	-0.213***	-0.208***	-0.241***
	(0.038)	(0.040)	(0.038)	(0.038)	(0.038)	(0.051)
Input tariff $^{i}_{t}$	-0.054	-0.066	-0.045	-0.038	-0.035	-0.044
	(0.086)	(0.088)	(0.085)	(0.086)	(0.086)	(0.085)
Input tariff $^{i}_{t}$ x $FM_{f,t}$	-0.465***	-0.395***	-0.463***	-0.500***	-0.481***	-0.849***
	(0.077)	(0.084)	(0.076)	(0.078)	(0.078)	(0.156)
$FX_{f,t}$=1 if export share >0	0.050***	0.045***	0.050***	0.059***	0.058***	0.062***
	(0.008)	(0.009)	(0.008)	(0.008)	(0.008)	(0.011)
$FM_{f,t}$=1 if import share>0	0.086***	0.067***	0.086***	0.096***	0.094***	0.145***
	(0.010)	(0.010)	(0.010)	(0.010)	(0.010)	(0.019)
Skill share $^{i}_{f,t}$			0.287***	0.279***	0.278***	0.279***
			(0.018)	(0.018)	(0.018)	(0.018)
ln(labor) $^{i}_{f,t}$				-0.069***	-0.072***	-0.070***
				(0.005)	(0.005)	(0.005)
$FF_{f,t}$=1 if foreign share ≥0.1	0.100***		0.101***	0.110***	0.110***	0.131***
	(0.012)		(0.012)	(0.013)	(0.013)	(0.016)
Govt share $_{f,t}$	0.064***	0.068***	0.063***	0.063***	0.058***	0.059***
	(0.010)	(0.010)	(0.009)	(0.009)	(0.009)	(0.009)
$Exit_{f,t}$=1 if firm exits in t+1					-0.047***	-0.048***
					(0.005)	(0.005)
Firm fixed effects	yes	yes	yes	yes	yes	yes
Island x year	yes	yes	yes	yes	yes	yes
Jakarta x year	yes	yes	yes	yes	yes	yes
Observations	185,866	175,463	185,866	185,866	185,866	185,866
R-squared	0.85	0.85	0.85	0.86	0.86	0.86

Robust standard errors in parentheses * significant at 10%; ** significant at 5%; *** significant at 1%

Table 3B: Tariffs and Wages – Sensitivity

Dependent Variable: $\ln(\text{wage})^{i}_{f,t}$	Asian Crisis			Weighted tariffs	Duty Free Zone
	1991-1996	Input tariffs (I/O 1995)	Input tariffs (I/O 1998)		
	(1)	(2)	(3)	(4)	(5)
Output tariff^{i}_{t}	0.086	0.090**	0.100***	0.056*	0.100**
	(0.054)	(0.036)	(0.036)	(0.029)	(0.045)
Output tariff^{i}_{t} x $FX_{f,t}$	-0.132***	-0.222***	-0.206***	-0.113***	-0.208***
	(0.046)	(0.039)	(0.038)	(0.037)	(0.039)
Input tariff^{i}_{t}	0.087	-0.068	-0.127**	-0.071*	-0.034
	(0.132)	(0.049)	(0.064)	(0.037)	(0.086)
Input tariff^{i}_{t} x $FM_{f,t}$	-0.436***	-0.163***	-0.243***	-0.433***	-0.477***
	(0.105)	(0.042)	(0.064)	(0.074)	(0.078)
Input tariff^{i}_{t} x $FM_{f,t}$ x free					-0.338
					(0.313)
$FX_{f,t}$=1 if export share >0	0.066***	0.060***	0.058***	0.039***	0.058***
	(0.012)	(0.008)	(0.008)	(0.008)	(0.008)
$FM_{f,t}$=1 if import share>0	0.077***	0.055***	0.059***	0.081***	0.094***
	(0.015)	(0.006)	(0.007)	(0.008)	(0.010)
Skill $\text{share}^{i}_{f,t}$	0.260***	0.278***	0.278***	0.278***	0.278***
	(0.020)	(0.018)	(0.018)	(0.018)	(0.018)
$\ln(\text{labor})^{i}_{f,t}$	-0.073***	-0.071***	-0.071***	-0.070***	-0.072***
	(0.008)	(0.005)	(0.005)	(0.005)	(0.005)
$FF_{f,t}$=1 if foreign share ≥0.1	0.090***	0.110***	0.110***	0.108***	0.110***
	(0.017)	(0.013)	(0.013)	(0.013)	(0.013)
Govt $\text{share}_{f,t}$	0.034**	0.056***	0.057***	0.057***	0.058***
	(0.015)	(0.009)	(0.009)	(0.009)	(0.009)
$\text{Exit}_{f,t}$=1 if firm exits in t+1	-0.038***	-0.048***	-0.048***	-0.048***	-0.047***
	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)
Free trade=1 if firm in DFZ					-0.187
					(0.235)
Firm fixed effects	yes	yes	yes	yes	yes
Island x year	yes	yes	yes	yes	yes
Jakarta x year	yes	yes	yes	yes	yes
Observations	105,262	185,866	185,866	184,928	185,866
R-squared	0.87	0.86	0.86	0.86	0.86

Robust standard errors in parentheses * significant at 10%; ** significant at 5%; *** significant at 1%

Table 4: Tariffs and Wages – 5-period differences

Dependent Variable: $\ln(\text{wage})^{i}_{f,t}$	OLS						2SLS
	Output tariff	With exporters	Input tariff	With importers	All	With trade shares	With trade shares
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
ΔOutput tariff$^{i}_{t}$	0.099*	0.156**			0.164**	0.152*	0.336*
	(0.058)	(0.062)			(0.083)	(0.082)	(0.187)
ΔOutput tariff$^{i}_{t}$ x $FX_{f,t-5}$		-0.411***			-0.341***	-0.455***	-0.667***
		(0.087)			(0.084)	(0.100)	(0.141)
ΔInput tariff$^{i}_{t}$			-0.026	0.059	-0.043	-0.050	-0.251
			(0.093)	(0.087)	(0.137)	(0.135)	(0.196)
ΔInput tariff$^{i}_{t}$ x $FM_{f,t-5}$				-0.768***	-0.632***	-1.077***	-1.178***
				(0.132)	(0.126)	(0.209)	(0.315)
$\Delta FX_{f,t}$	0.020***	0.049***	0.020***	0.023***	0.046***	0.055***	0.072***
	(0.007)	(0.009)	(0.007)	(0.007)	(0.009)	(0.012)	(0.014)
$\Delta FM_{f,t}$	0.037***	0.036***	0.037***	0.063***	0.057***	0.078***	0.082***
	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)	(0.019)	(0.020)
ΔSkill share$^{i}_{f,t}$	0.285***	0.286***	0.284***	0.283***	0.285***	0.286***	0.287***
	(0.028)	(0.028)	(0.028)	(0.028)	(0.028)	(0.028)	(0.028)
$\Delta\ln(\text{labor})^{i}_{f,t}$	-0.060***	-0.063***	-0.060***	-0.063***	-0.064***	-0.063***	-0.064***
	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)
$\Delta FF_{f,t}$	0.104***	0.104***	0.104***	0.104***	0.105***	0.129***	0.125***
	(0.021)	(0.020)	(0.021)	(0.020)	(0.020)	(0.027)	(0.027)
ΔGovt share$_{f,t}$	0.060***	0.061***	0.060***	0.064***	0.064***	0.066***	0.069***
	(0.014)	(0.014)	(0.014)	(0.014)	(0.014)	(0.014)	(0.014)
Island x year	yes	yes	yes	yes	yes	yes	yes
Jakarta x year	yes	yes	yes	yes	yes	yes	yes
Weak instruments							$\chi^2(2)$=1,267
Overidentification							3.58
Hansen J statistic							0.17
Observations	55,393	55,393	55,393	55,393	55,393	55,393	55,393
R-squared	0.03	0.04	0.03	0.04	0.04	0.04	0.03

Notes: Robust standard errors in parentheses; * significant at 10%; ** significant at 5%; *** significant at 1%. Instruments include 1991 industry skill share, 1991 industry skill share interacted with 5-period lagged export dummy, 1991 input tariff level, 1991 input tariff level interacted with 5-period lagged import dummy, exclusion dummy=1 if 10 or more HS9-digit products excluded within a 5-digit industry code from commitment to reduce bound tariffs to 40%, and non-tariff dummy=1 if 10 or more HS 9-digit product codes were subject to non-tariff barriers.

Appendix

Table A1: Summary Statistics

Variable	Mean	Standard deviation
ln(wage) $^{i}_{f,t}$	7.35	0.81
ln(labor) $^{i}_{f,t}$	4.18	1.19
Skill share$^{i}_{f,t}$	0.14	0.15
Foreign share$_{f,t}$	0.04	0.18
FF=1 if foreign share>=0.1	0.06	0.23
Export share$_{f,t}$	0.11	0.29
Export share$_{f,t}$ if FX=1	0.71	0.33
FX$_{f,t}$ =1 if exshare>0	0.15	0.36
Import share$_{f,t}$	0.09	0.24
Import share$_{f,t}$ if FM=1	0.47	0.36
FM$_{f,t}$=1 if import share >0	0.19	0.39
Govt share$_{f,t}$	0.02	0.14
Free trade=1 if firm in FTA	0.01	0.08
Exit$_{f,t}$	0.08	0.28
Output tariff$^{i}_{t}$	0.17	0.11
ΔOutput tariff$^{i}_{t}$ (5-period difference)	-0.09	0.13
Input tariff$^{i}_{t}$	0.11	0.06
ΔInput tariff$^{i}_{t}$ (5-period difference)	-0.05	0.04
Observations	185,866	