MODELING THE EFFECTS OF LABOR STANDARDS ON TRADE AND WAGES

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ECONOMICS WORKING PAPER SERIES
Working Paper 2020–12–A

U.S. INTERNATIONAL TRADE COMMISSION
500 E Street SW
Washington, DC 20436

December 2020

 The author thanks Peter Herman and Samantha Schreiber for helpful comments and suggestions.

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Abstract

We develop a model that quantifies the economic effects of policies intended to harmonize labor standards across countries, including labor provisions in international trade agreements. The model focuses specifically on collective bargaining. We consider alternative views of labor standards in the context of the model and examine the possibility that labor standards can increase supply efficiency and lower prices. The model identifies the specific data requirements of the quantification. While it can be difficult to meet some of the data requirements and predict the exact magnitude of the economic effects of changes in labor standards, the model provides a tool for estimating upper and lower bounds on these effects even when data availability is limited.

JEL Codes: F2, F6, J5, J8

Keywords: Labor standards, international trade, wage bargaining, offshoring

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1 Introduction

Labor standards refer to a wide range of policies and institutions that affect wages and employment, including the right to collective bargaining and prohibitions on child labor. Provisions to improve labor conditions are an important part of modern trade agreements, including the recent USMCA.

There is a large economic literature that debates the effects of labor standards on trade and wages. There are many excellent overviews of the issues, including Brown, Deardorff and Stern (1996), Rodrik (1996), Krueger (1996), Brown (2001), Stern (2003), Dehejia and Samy (2004), Bonnal (2010), and Salem and Rozental (2012). One side of the debate views labor standards as a matter of fairness, as a means to protect fundamental rights of workers. The other side of the debate views labor standards as a disguised form of protectionism, an attempt to avoid a race to the bottom that would undermine the competitiveness of countries with higher labor standards.[1]

To these common views we add the possibility that labor standards can increase supply efficiency by reducing or eliminating distortions in the international location of production. In this paper, we focus on collective bargaining and start from the International Labour Organization's premise that collective bargaining is a core labor standard that is already firmly established in advanced countries.[2] In this paper, we analyze the effects of increasing labor standards in developing countries to the standards in their trading partners. We define supply efficiency in terms of the opportunity cost of resources used in production and international trade. Supply efficiency means maximizing a firm's surplus of revenue over the opportunity cost of factors of production and trade regardless of how that surplus is distributed between the firm's profits and the compensation of its workers. With efficiency

[1] Davies and Vadlamannati (2013) explain the race to the bottom view and provide evidence of a positive international correlation in labor standard enforcement across countries.

[2] The consensus around core labor standards is discussed in Brown (2001).

bargaining, production levels will be set based on the opportunity cost of the workers and prices will be a mark-up over these opportunity costs, not the bargained wage. For this reason, labor standards that facilitate bargaining can redistribute the surplus and increase wages without distorting production levels and prices, and international harmonization of labor standards can eliminate distortions in the location of production.

We develop an economic model that quantifies the effects of improving labor standards on wages, international trade flows, employment, and prices. We focus specifically on collective bargaining. The model identifies the data requirements of the quantification. While it can be difficult to meet some of the data requirements and predict the exact magnitudes of these economic effects, the model provides a tool for estimating upper and lower bounds on these economic effects even when data availability is limited.

The rest of the paper is organized in six parts. Section 2 presents the modeling framework. Section 3 uses the the model to demonstrate the potential for improved labor standards to increase supply efficiency and lower prices. Section 4 discusses the upper and lower bounds on cross-border price effects and reports estimates from model simulations. Section 5 examines the economic effects of a change in labor standards combined with tariff reductions. Section 6 extends the model by adding fixed costs that affect location decisions. Section 7 concludes with a summary of findings, a brief discussion of the econometric literature on the effects of labor standards on trade and wages, and a short discussion of potential extensions of the model.

2 Modeling Framework

In the model, there are several production locations indexed by j and several national markets indexed by m. Firms decide on the location of production that will supply each national market. The model analyzes a firm's decisions about its production locations and its em-

ployment and labor compensation in each country. These decisions determine equilibrium prices and international trade flows.

We assume that the firm sells a differentiated product and competes in an industry with the constant elasticity of substitution demand function in equation (1).

$$q_{ijm} = k_m \ (p_{ij} \ t_{jm})^{-\sigma} \tag{1}$$

q_{ijm} is the quantity demanded of the variety of firm i produced in country j, p_{ij} is the price of firm i products from j, $t_{jm} \geq 1$ is an ad valorem trade cost of supplying the product from country j to country m, including any tariffs that apply, and $\sigma > 1$ is the elasticity of substitution. $p_{ij} \ t_{jm}$ is the delivered price in country m. k_m is a market factor that is equal to $E_m \ (P_m)^{\sigma-1}$, where E_m is aggregate expenditure in m on the products of the industry, and P_m is the industry's CES price index in m.[3]

Equation (2) is firm i's unit cost of production in country j, the competitive or opportunity cost of firm i's workers in j.

$$c_{ij} = \theta_{ij} \ z_j \tag{2}$$

z_j is the competitive wage available to workers in j.[4] θ_{ij} is firm i's unit labor requirement in j and the reciprocal of its labor productivity. c_{ij} does not take into account any premium in labor compensation from bargaining.[5] The partial equilibrium model treats the competitive wage z_j as an exogenous variable.

There is monopolistic competition, and each firm is endowed with a unique asset that generates rents.[6] The producer price is a constant mark-up over the firm's marginal costs of

[3] k_m is an exogenous variable in the model. This small exporter assumption is a common partial equilibrium simplification in international trade models, e.g., Handley and Limão (2015).

[4] To simplify the equations, the model does not include non-labor factors of production, but they could be added if the model is applied to industries where they are important.

[5] Generally the bargained wage, w_{ij}, will be greater than z_j, as we discuss below.

[6] Models of multinational firms and foreign direct investment often focus on the importance of firm-specific assets like unique technology or global brand reputation. Riker and Wickramarachi (2020) discuss

production, specifically the opportunity cost of its workers rather than the total compensation that it pays them as a result of bargaining.

$$p_{ij} = \left(\frac{\sigma}{\sigma \ - \ 1} \right) \ c_{ij} \tag{3}$$

Labor compensation in firm i is determined by Nash bargaining in every country with higher labor standards.[7] This bargaining model appears to be the most common representation of wage bargaining in models of international trade. Examples include Gaston and Trefler (1995), Davidson, Martin and Matusz (1999), and Davidson and Matusz (2004).[8]

We assume that union workers in firm i in country j have the following objective function, based on McDonald and Solow (1981):

$$Y_{ij}\left(L_{ij}, w_{ij}\right) = L_{ij} \ w_{ij} + \left(N_{ij} \ - \ L_{ij}\right) \ z_j \ - N_{ij} \ z_j = L_{ij} \ \left(w_{ij} \ - \ z_j\right) \tag{4}$$

N_{ij} is firm i's total union membership in country j, L_{ij} is the employment in firm i in country j, and w_{ij} is the bargained labor compensation of each of its union workers. We assume that the firm's objective for its production in j is its profits after paying bargained labor compensation:

$$V_{ij}\left(L_{ij}, w_{ij}\right) = \left(p_{ij} \ - \theta_{ij} \ w_{ij}\right) \ q_{ijm}\left(L_{ij}\right) \tag{5}$$

The Nash bargaining solution is the employment level L_{ij} and wage rate w_{ij} that maximizes $\left(Y_{ij}\left(L_{ij}, w_{ij}\right)\right)^{\lambda_j} \ \left(V_{ij}\left(L_{ij}, w_{ij}\right)\right)^{1-\lambda_j}$ subject to the firm's and workers' participation constraints $Y_{ij}\left(L_{ij}, w_{ij}\right) \geq 0$ and $V_{ij}\left(L_{ij}, w_{ij}\right) \geq 0$. λ_j is the union's Nash bargaining share in j, typically set to 0.5.

many examples from this literature.

[7] McDonald and Solow (1981) and Binmore, Rubinstein and Wolinsky (1986) compare Nash bargaining to other forms of wage bargaining.

[8] The Stole-Zwiebel bargaining model in Helpman and Itskhoki (2010) and Helpman, Itskhoki and Redding (2010) is an extension of Nash bargaining.

With a constant bargaining share and a constant mark-up of price over opportunity costs, the bargained wage w_{ij} is simply a function of the elasticity of substitution, the workers' bargaining share, and the opportunity cost or competitive wage available to the workers. The equilibrium level of employment L_{ij} maximizes the total surplus by setting the price-valued marginal product of labor equal to the opportunity cost of the workers, the competitive wage z_j (not by setting it equal to the bargained wages that includes a share of the surplus). Equation (6) is the equilibrium total labor compensation per worker in firm i if the firm produces in country j.

$$w_{ij} = z_j \ + \ \lambda_j \ \left(\frac{p_{ij} \ - \ c_{ij}}{\theta_{ij}} \right) = z_j \ + \ \lambda_j \ \frac{z_j}{\sigma \ - \ 1} \tag{6}$$

Total labor compensation is a combination of the competitive wage z_j and a share of the surplus when $\lambda_j > 0$.

We assume that the firm first chooses where to locate production to supply each national market before bargaining over wages and the employment level. The firm chooses the location that will supply market m that maximizes the firm's profits, π_{im}, taking into account whether there is collective bargaining in each of the potential production locations indexed by j.

$$\pi_{im} = \max_j (1 \ - \ \lambda_j) \ (p_{ij} \ - \ c_{ij}) \ q_{ijm} = \max_j (1 \ - \ \lambda_j) \ k_m \ (\theta_{ij} \ z_j \ t_{jm})^{1 \ - \ \sigma} \tag{7}$$

We assume that labor standards affect the bargaining share in the following way: if there is collective bargaining in country j, then $\lambda_j = 0.5$. If there is not, then $\lambda_j = 0$. After the location of production has been set, the firm and the workers bargain over wages and employment levels within each production location, as specified in equations (4), (5), (6), and (7).

In the examples below, we assume that there are three countries: A, B, and C. We assume

that country A has high standards represented by $\lambda_A = 0.5$ and that country C has low standards represented by $\lambda_C = 0$. We use the model to estimate the effects of changing labor standards in country B, from $\lambda_B = 0$ to $\lambda_B = 0.5$, on the location of production, international trade flows, wages, employment, and prices. When $\lambda_B = 0$, there are different bargaining shares in A and B. In this case, bargaining does not distort employment levels and prices given location decisions, but it affects the location of production. When $\lambda_B = \lambda_A = 0.5$, there is no distortion due to asymmetric labor standards.

In general, an increase in λ_B will increase wages in B as long as production still remains in B. The workers in B gain bargaining power. However, bargaining in B may reduce employment in B if it reduces domestic shipments in B or exports to other countries. This is the disguised protectionism effect of labor standards. Likewise, bargaining in B may increase imports into B. Finally, bargaining in B can increase or decrease the cost of supplying each national market, including production and trade costs, and so prices to consumers can rise or fall in B and in other national markets initially supplied by B. It is possible that workers in A benefit *and* consumers in A do not face higher prices. We discuss this potential supply efficiency gain from improved labor standards in the next section.

3 The Potential to Increase Supply Efficiency

It is common to assume that labor standards that increase wages will also reduce international competitiveness. As Salem and Rozental (2012) points out, this assumption underlies race to the bottom concerns about labor standards. However, this is not the case with the Nash bargaining model in equations (4) through (7).[9] When there is collective bargaining in country A but not in country B, decisions about the location of production can be distorted. The firm might not build the international supply chain that minimizes the opportunity cost

[9]There are other types of labor standards, like minimum wage policies, that also increase labor compensation but might have negative effects on supply efficiency if they affect employment levels.

of production and transport to each market. A firm might choose to maximize its profits by locating production in a country that does not allow collective bargaining in order to avoid splitting its surplus with its workers, even if this reduces the total surplus by reducing its supply efficiency.[10] Conversely, a different division of the total surplus can increase the total surplus. Supply efficiency depends on the opportunity cost of workers and international trade costs. It depends on the competitive wage, not on the workers' total compensation if this compensation includes a share of the surplus.

This efficiency case for labor standards is different from the disguised protectionism view of labor standards. In both cases, improving labor standards in B increases wages in B and can lead to a relocation of production to A; however, with Nash bargaining, the relocation of production to A *only happens when it reduces the total cost of supplying the market in* A. In the model, prices in market m will decline when labor standards in B improve from $\lambda_B = 0$ to $\lambda_B = \lambda_A$ if inequality (8) is satisfied.

$$\max_j (1 - \lambda_A)\ k_m\ (\theta_{ij}\ z_j\ t_{jm})^{1-\sigma} < \max_j\ k_m\ (\theta_{ij}\ z_j\ t_{jm})^{1-\sigma} \tag{8}$$

Consider the following example: country B initially exports to A and then after the improvement in labor standards in B, A is supplied by local production. The relocation of production to A reveals that this is a more cost-effective way to supply A, either due to a lower opportunity cost of labor, lower trade costs, or both. For example, suppose that production and trade costs are such that the market in A is only supplied by exports from B if $\lambda_B < \lambda_A$. As long as the inequalities in (9) and (10) are satisfied, production for market A relocates to A when λ_B rises from 0 to λ_A.

$$(\theta_{iB}\ z_B\ t_{BA})^{1-\sigma} > (\theta_{iA}\ z_A)^{1-\sigma}\ (1 - \lambda_A) \tag{9}$$

[10]There are other scenarios when labor standards can increase efficiency, as Krueger (1996) notes. For example, labor standards might increase incentives for worker to invest in human capital.

$$(\theta_{iB}\ z_B\ t_{BA})^{1\ -\ \sigma} < (\theta_{iA}\ z_A)^{1\ -\ \sigma} \tag{10}$$

In this example, the improvement in labor standards in B reduces the total cost of supplying A and increases supply efficiency. It reduces price in A, since

$$p_{iB}\ t_{BA} = \left(\frac{\sigma}{\sigma\ -\ 1}\right)\ (\theta_{iB}\ z_B\ t_{BA}) > \left(\frac{\sigma}{\sigma\ -\ 1}\right)(\theta_{iA}\ z_A) = p_{iA} \tag{11}$$

It will also reduce prices in B if it becomes more efficient to supply B by exporting from A.

4 Quantifying Economic Effects

The economic effects of labor provisions in trade agreements depend critically on whether the policies are enforced. If the standards are not enforced for political reasons or because there is not an effective mechanism for dispute resolution, then they will have no economic effects. There has been criticism of labor provisions in past trade agreements and significant efforts to strengthen enforcement mechanisms in newer agreements. Any attempt to predict the economic effects of provisions that establish higher labor standards needs to evaluate the strength of the enforcement mechanism.[11] In this section, we estimate economic effects *assuming* that this evaluation has taken place and that indicates that the labor standards will be effectively enforced.

If all of the data inputs of the model are available for a specific industry and market – including the elasticity of substitution, the competitive wage, trade costs, the presence or absence of bargaining, and the size of the market in each country – then the estimation of economic effects is straightforward using the model in Section 2.

However, even if some of the data inputs of the model are not available, it might still be

[11] Riker (2020) discusses methods for modeling enforcement. Dewan and Ronconi (2018) provides some empirical evidence that signing trade agreements with the United States increased the enforcement of labor standards, specifically the number of labor inspections, in Latin American countries.

feasible to estimate upper and lower bounds on the economic effects. We illustrate this with another example that focuses on the change in delivered prices to consumers in A due to improved labor standards in B. If market A is initially supplied by production in A, B or C and the firm does not relocate production in response to the change in labor standards in B, then there is no changes in delivered prices in A. On the other hand, if A is initially supplied from B and this supply is relocated to A, then the proportional change in the delivered price to A is equal to $\frac{c_A - c_B\ t_{AB}}{c_B\ t_{AB}}$. The price in A declines, since relocation to A implies that

$$(c_A)^{1\ -\ \sigma} > (c_B\ t_{BA})^{1\ -\ \sigma} \tag{12}$$

This implies that $c_A < c_B\ t_{BA}$ and $p_A < p_B\ t_{BA}$, since $\sigma > 1$, and so the lower bound on the price *decline* in A is zero.[12] If B is initially supplied from production in A, then the inequality in (13) is also satisfied.

$$(c_A)^{1\ -\ \sigma}\ (1\ -\ \lambda_A) < (c_B\ t_{BA})^{1\ -\ \sigma} \tag{13}$$

The cost reduction and price reduction from relocating production to A is bounded from above: if the potential cost reductions were larger, then it would have been profitable for the firm to relocate to A before the increase in λ_B, but the firm's initial location decision indicates that it was not. For this reason, the upper bound on the percent decline in the price in A is equal to $1\ -\ (1\ -\ \lambda_A)^{\frac{1}{\sigma\ -\ 1}}$. For example, if λ_A is equal to 0.5, λ_B is initially equal to 0, σ is equal to 5, and the firm relocates production from B to A when λ_B is increased to 0.5, then the upper bound on the price decline is equal to 16%.

Tables 1 and 2 provide numerical examples based on the model in Section 2. In both simulations, $\lambda_A = 0.5$, $\lambda_C = 0.0$, and λ_B increases from 0.0 to 0.5. Competitive unit labor costs ($\theta_{ij}\ z_j$) are set equal to 1, the elasticity of substitution (σ) is set equal to 5, and the

[12] In other words, prices decline or stay the same. They do not increase.

market size parameter (k_m) is set equal to 1000 in each of the three markets. The difference between the two examples is their assumption about how distant C is from A and B.

In the first simulation, reported in Table 1, the firm initially supplies A by exporting from B, and supplies C and B from local production. The improvement in labor standards in B increases the wage in B. It increases employment in C while reducing employment in B. It also shifts the pattern of international trade. C becomes an exporter to A and B, since it still has an advantage from its lower labor standards. There is an increase in consumer prices in A and B due to higher trade costs. In this example, it is slightly more expensive to supply A and B after the increase in λ_B.

In the second simulation, reported in Table 2, the starting point is the same: the firm initially supplies A by exporting from B, and supplies C and B from local production. The improvement in labor standards in B increases the wage in B. However, in this second simulation the improvement in labor standards in B increases the firm's employment in A while reducing its employment in B. The change in labor standards in B eliminates cross-border trade. There is a reduction in consumer prices in A, since there are no longer international trade costs. The difference between the two simulations is that it is much more expensive to source from C in the second simulation. This case is more likely if C is located far from A and B.

As a third example, consider a case where B and C both have a relatively low competitive wage, so $z_B = z_C = 0.7 < z_A = 1.00$. In this simulation, B remains the low cost supplier of A, and so it continues to export to A even when λ_B increases from 0 to 0.5. The wage in B increases with bargaining, but otherwise the economic status quo is maintained. There is no change in the pattern of international trade, and the price in A is not affected.

Table 1: First Simulation of Increased Labor Standards in B

	Initial Equilibrium	New Equilibrium
Inputs		
Bargaining Share in A	0.5	0.5
Bargaining Share in B	0.0	0.5
Bargaining Share in C	0.0	0.0
Trade Cost Factors between A and B	1.10	1.10
Trade Cost Factors with C	1.11	1.11
Outcomes		
Value of Shipments from B to A	279.76	0.00
Value of Shipments from C to A	0.00	269.82
Value of Shipments from A to B	0.00	0.00
Value of Shipments from C to B	0.00	269.82
Value of Shipments from A to C	0.00	0.00
Value of Shipments from B to C	0.00	0.00
Wages in A	1.13	1.13
Wages in B	1.00	1.13
Wages in C	1.00	1.00
Industry Employment in A	0.00	0.00
Industry Employment in B	531.14	0.00
Industry Employment in C	327.68	716.60
Delivered Price in A	1.38	1.39
Delivered Price in B	1.25	1.39
Delivered Price in C	1.25	1.25

Table 2: Second Simulation of Increased Labor Standards in B

	Initial Equilibrium	New Equilibrium
Inputs		
Bargaining Share in A	0.5	0.5
Bargaining Share in B	0.0	0.5
Bargaining Share in C	0.0	0.0
Trade Cost Factors between A and B	1.10	1.10
Trade Cost Factors with C	1.30	1.30
Outcomes		
Value of Shipments from B to A	279.76	0.00
Value of Shipments from C to A	0.00	0.00
Value of Shipments from A to B	0.00	0.00
Value of Shipments from C to B	0.00	0.00
Value of Shipments from A to C	0.00	0.00
Value of Shipments from B to C	0.00	0.00
Wages in A	1.13	1.13
Wages in B	1.00	1.13
Wages in C	1.00	1.00
Industry Employment in A	0.00	327.68
Industry Employment in B	531.14	327.68
Industry Employment in C	327.68	327.68
Delivered Price in A	1.38	1.25
Delivered Price in B	1.25	1.25
Delivered Price in C	1.25	1.25

Table 3: Third Simulation of Increased Labor Standards in B

	Initial Equilibrium	New Equilibrium
Inputs		
Bargaining Share in A	0.5	0.5
Bargaining Share in B	0.0	0.5
Bargaining Share in C	0.0	0.0
Trade Cost Factors between A and B	1.10	1.10
Trade Cost Factors with C	1.30	1.30
Outcomes		
Value of Shipments from B to A	1165.19	1165.19
Value of Shipments from C to A	0.00	0.00
Value of Shipments from A to B	0.00	0.00
Value of Shipments from C to B	0.00	0.00
Value of Shipments from A to C	0.00	0.00
Value of Shipments from B to C	0.00	0.00
Wages in A	1.13	1.13
Wages in B	0.70	0.79
Wages in C	0.70	0.70
Industry Employment in A	0.00	0.00
Industry Employment in B	3160.25	3160.25
Industry Employment in C	1949.66	1949.66
Delivered Price in A	0.96	0.96
Delivered Price in B	0.88	0.88
Delivered Price in C	0.88	0.88

5 Labor Standards with Trade Liberalization

Next, we consider the interaction between improvements in labor standards and tariff reductions, since labor provisions are often embedded in trade agreements. If A is initially supplied by local production, then inequality (14) is satisfied.

$$(c_{iB}\ t_{BA})^{1\ -\ \sigma} < (c_{iA})^{1\ -\ \sigma}\ \ (1\ -\ \lambda_A) \tag{14}$$

Suppose the trade agreement reduces t_{BA} to 1 and increases λ_B from 0 to 0.5. If the firm is still producing in A, then inequality (15) is satisfied.

$$(c_{iB})^{1\ -\ \sigma} < (c_{iA})^{1\ -\ \sigma} \tag{15}$$

In this case, the incentive to move production to B from the tariff reduction is offset by the increase in labor standards in B. The wage in B increases, but there is no change in international trade flows and no effect on consumer prices in either country. This is depicted in the second column of estimates in Table 4.[13]

On the other hand, if there is only a reduction in t_{BA} without an increase in labor standards in B, then B will export to A and there will be *higher* delivered prices in A, though the tariffs on exports from B to A are *reduced*. The firm reduces total surplus by relocating production to low labor standard B but is able to retain a larger share of the smaller surplus – all of it. This is depicted in the third column of estimates in Table 4.

[13]The simulations in Table 4 all assume that $a_{ij}\ z_j = 1$, $\sigma = 5$, and $k_m = 1000$, as in Table 1.

Table 4: Increasing Labor Standards While Reducing Tariffs

	Initial Equilibrium	Increase Labor Standard and Lower Tariff	Lower Tariff Only
Inputs			
Bargaining Share in A	0.5	0.5	0.5
Bargaining Share in B	0.0	0.5	0.0
Bargaining Share in C	0.0	0.0	0.0
Trade Cost Factors between A and B	1.20	1.10	1.10
Trade Cost Factors with C	1.21	1.21	1.21
Outcomes			
Value of Shipments from B to A	0.00	0.00	279.76
Value of Shipments from C to A	0.00	0.00	0.00
Value of Shipments from A to B	0.00	0.00	0.00
Value of Shipments from C to B	0.00	0.00	0.00
Value of Shipments from A to C	0.00	0.00	0.00
Value of Shipments from B to C	0.00	0.00	0.00
Wages in A	1.13	1.13	1.13
Wages in B	1.00	1.13	1.00
Wages in C	1.00	1.00	1.00
Industry Employment in A	327.68	327.68	0.00
Industry Employment in B	327.68	327.68	531.14
Industry Employment in C	327.68	327.68	327.68
Delivered Price in A	1.25	1.25	1.38
Delivered Price in B	1.25	1.25	1.25
Delivered Price in C	1.25	1.25	1.25

6 Adding Fixed Costs That Affect Location Decisions

The model in Section 2 does not include fixed costs of production, and that makes the model very tractable. In this section, we extend the model by adding fixed costs of production in each location j that are specific to the market supplied m.[14] These fixed costs are represented by f_{ijm}.

We return to the example in Section 3, in which A is initially supplied by exports from B and then after the improvement in labor standards in B the firm's production for A is relocated to A. The firm's fixed costs of production in B to supply A are f_{iBA}, and its fixed costs of production in A to supply A are f_{iAA}. With this extension, there are still upper and lower bounds on the price in A after an improvement in labor standards in B, and so there are bounds on the price change. Inequality (16) implicitly defines the upper bound on the price in A after the change in labor standards in B.

$$k_A \ (p_{iA})^{1\,-\,\sigma} \ - \ f_{iAA} > k_A \ (p_{iB}\ t_{BA})^{1\,-\,\sigma} \ - \ f_{iBA} \tag{16}$$

Inequality (17) implicitly defines the lower bound on the price in A after the change in labor standards in B.

$$\left(k_A \ (p_{iA})^{1\,-\,\sigma} \ - \ f_{iAA}\right) \ (1 \ - \ \lambda_A) < k_A \ (p_{iB}\ t_{BA})^{1\,-\,\sigma} \ - \ f_{iBA} \tag{17}$$

These two inequalities imply that the new price p_{iA} will be between ${p_{iA}}^{LB}$ and ${p_{iA}}^{UB}$.

$${p_{iA}}^{LB} = \left(\left(f_{iAA}\,(1-\lambda_A) - f_{iBA}\right) \ \left(\frac{1}{k_A}\right) \ \left(\frac{1}{1-\lambda_A}\right) + (p_{iA0})^{1-\sigma} \left(\frac{1}{1-\lambda_A}\right)\right)^{\frac{1}{1-\sigma}} \tag{18}$$

[14]The assumption that fixed costs are specific to the market supplied is a common simplifying assumption in models of international trade with fixed costs, including Melitz (2003), because it results in separability of export decisions across destination countries. If fixed costs are common or shared across markets, then the location decisions of the firm would be more complex.

$$p_{iA}{}^{UB} = \left((f_{iAA} - f_{iBA}) \left(\frac{1}{k_A} \right) + (p_{iA0})^{1-\sigma} \right)^{\frac{1}{1-\sigma}} \tag{19}$$

p_{iA0} is the initial price of firm i in A, which is equal to $\left(\frac{\sigma}{\sigma-1}\right)\ c_{iB}\ t_{BA}$ in this example.

In the restricted case in Sections 2 and 3, $f_{iAA} = f_{iBA} = 0$, so $p_{iA}{}^{UB} = p_{iA0}$ and $p_{iA}{}^{LB} = p_{iA0}\,(1-\lambda_A)^{\frac{1}{\sigma-1}}$. In a less restricted case, where the fixed costs are the same but not equal to zero ($f_{iAA} = f_{iBA} = f_i$), $p_{iA}{}^{UB}$ is still equal to p_{iA0}, but $p_{iA}{}^{LB}$ depends on the magnitude of the common fixed cost f_i: a larger fixed cost reduces the lower bound on p_{iA} (and increases the the upper bound on the decline in the price).

$$p_A^{LB} = \left(-f_i\ \lambda_A \left(\frac{1}{k_A} \right) \left(\frac{1}{1-\lambda_A} \right) + (p_{iA0})^{1-\sigma} \left(\frac{1}{1-\lambda_A} \right) \right)^{\frac{1}{1-\sigma}} \tag{20}$$

When there is no restriction, and $f_{iAA} \neq f_{iBA}$, the bound on the new price in A are defined by (18) and (19). In this case, the improvement in labor standards in B can *reduce or increase* the price in A if the firm relocates production to A, depending on the data inputs of the model. Producing in A may be more attractive due to lower fixed costs but have higher variable costs; in this case, the relocation will result in higher prices.

As we would expect, when fewer restrictions are placed on the model, more data are required to estimate the price effects. The extension of the model in (18) and (19) requires values for k_A as well as f_{iAA} and f_{iBA}.

7 Conclusions

The model of labor standards, trade, and wages demonstrates the possibility that harmonizing labor standards across borders can not only increase wages, alter trade flows, and shift employment, but also improve supply efficiency and lower prices to consumers. This is a possibility, not a general finding. It will depend on conditions in the specific industry and

market where the labor standards are improved, including the efficacy of enforcement. The modeling framework in this paper identifies the specific data required to predict the price effects. The data requirements include firm-specific comparisons of production costs, trade costs, and labor standards. While it can be difficult to meet some of the data requirements and predict the exact magnitude of the economic effects of changes in labor standards, the model provides a tool for quantifying upper and lower bounds on these effects even when data availability is more limited.

The model demonstrates that the effects of labor standards vary depending on conditions in the industry, so it is not surprising that there is mixed evidence in the econometric literature that has tried to measure the effects of labor standards on trade and wages. Stern (2003) and Salem and Rozental (2012), for example, conclude that there is not clear evidence that labor standards affect trade and wages in other countries. Dehejia and Samy (2004) does not find an effect of unions and collective bargaining on export performance. Palley (2005) finds that labor standards improve income distribution and raise wages. Kucera and Sarna (2006) find that stronger trade unions are associated with higher manufacturing exports, though the finding is sensitive to model specification. Bonnal (2010) finds that countries with better labor standards and institutions have a higher ratio of exports to GDP.[15] In general, it is difficult to estimate the effects of labor standards using econometric analysis: there are many confounding factors, there is limited variation in labor standards over time, and it is difficult to determine how effectively new standards are enforced.

There are many economic complexities that are not addressed in the model in this paper but could be added. First, the model can be extended to include other factor inputs. Second, if the firm's rents were endogenously determined by innovation, then the introduction of

[15]This result can still be explained in terms of the model in this paper, since Bonnal (2010) is using aggregate trade data. With aggregation across firms, our model could predict higher exports as a ratio to GDP where there are higher labor standards, as Bonnal (2010) finds, if the increase in bargaining leads to a loss of competitiveness of domestic producers who do not export but does not significantly affect exporters.

collective bargaining and sharing of rents could reduce incentives to innovate, leading to fewer varieties and fewer firms. Third, there could be strategic interactions in product markets that are not captured in our monopolistic competition model. Fourth, there could be multinational bargaining, rather than the country-specific bargaining in our model. Finally, the model could be extended to include many time periods, and this would make investment decisions about the location of production significantly more complex.

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