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Labour Standards in Exports

and Developing Countries

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ABSTRACT

This paper investigates the impact labour regulation, as defined by labour standards, have on the international trade regime. After providing a description of the debate's landscape, the paper focuses on the questions: Could the adoption of a domestic labour standard improve welfare for an industrial country through the policy's effect on the international market? And, once such a policy is instituted what possible gains are there in encouraging the establishment of standards abroad? By allowing for strategic interaction between two countries, the paper shows that when an industrial country implements a labour standard domestically its optimal tariff on labour-intensive imports increases, forcing a decline in its trading partner's optimal import tariffs.

The second part of the paper goes on to investigate why industrial countries would then encourage labour standards adoption among developing countries as well. The key insight here is that if industrial countries are constrained explicitly on the tariff front from gaining an advantage in trade, by multilateral trade agreements for example, they will resort to 'second-best' policy options—demanding labour standard policies for their trading partners. The successful implementation of a labour standard in developing countries acts as a substitute for higher tariffs in the industrial countries, by partially alleviating the distortion caused by the industrial country's labour standard. Other authors, Brander and Spencer (1985), Eaton and Grossman (1986), have found an analogous result in which intervention into imperfect product markets, rather than imperfect factor markets, can lead to a similar improvement in a country's welfare.

Keywords: Labour standards in developing countries and trade policy.

JEL Classification:

F1

F13

J51

The failure of any nation to adopt humane conditions of labour is an obstacle in the way of other nations which desire to improve the conditions in their own countries.

-- *The Preamble to the International Labour Organization Constitution*

1. BACKGROUND TO THE DEBATE ON LABOUR STANDARDS

The debate surrounding the issue of including certain types of labour standards, collectively referred to as a 'social clause', into multilateral free-trade negotiations has recently grabbed much public attention. Labour standards can be defined loosely as any rule or regulation adopted by a government that affects some aspect of the labour market. These policies cover a wide range of social and political issues, such as maternity leave, unemployment insurance, time lost from work, minimum working age requirements, safe working conditions, and collective bargaining. As of 1994, 168 countries, including close to 98 per cent of the world's population, were members of the International Labour Organization (ILO), which is responsible for formulating and implementing these standards, or conventions, worldwide.

Member countries of the ILO are free to choose whether or not to ratify a convention. However, once they ratify the convention, they are required to apply the convention in industrial legislation and 'to submit to supervision by the appropriate ILO bodies' (ILO 1994). Supervision is carried out to ensure that the obligations assumed are continually fulfilled. In 1994, the number of ILO conventions stood at 174, with the average member country having ratified 34 standards, applied mostly through industrial legislation. More than 120 countries have signed conventions dealing with basic labour rights, such as freedom from forced labour, freedom to organize and bargain collectively, and equal remuneration for equal work.

The international social clause, discussed in policy circles, would potentially ban the use of child labour, require basic safety conditions in work environments, and perhaps require a minimum level of compensation to workers. The impetus for adopting such a clause has come mostly from the United States and the European Community, which argue that the delinquency of some developing countries in adopting these standards has

given the poorer countries an unfair advantage in the production of goods. To compete with this inflow of goods produced under unjust conditions, the United States and the European Community maintain that they are forced to participate in a 'race to the bottom' where countries with the fewest labour standards win the prize of international trade.

Insistence by the United States and France on including labour standards formally on the agenda of the World Trade Organization (WTO) almost held up signing of the Uruguay Round of the General Agreement on Tariffs and Trade in April 1994. In addition, due to deliberations in the US Congress about the inclusion of labour and environmental standards in trade agreements, Chile's placement on the fast track for acceptance into the North American Free Trade Agreement was delayed indefinitely in December 1995. Most recently in 1999, labour standards was one of the issues brought forward during the WTO meetings in Seattle.

US claims of poor labour conditions are exemplified in a range of circumstances varying from the extremely low wages of workers in Shenzen, China, to the use of children in carpets and textile production in Pakistan, and to the employment of slave labour in Peru. In November 1995, the US Department of Labor published a 210-page report called 'By the Sweat and Toil of Children', which cited the practice of child labour from the tobacco plantations of Brazil to the coffee fields in Guatemala and Honduras (US Department of Labor 1995).

To counter these arguments, developing countries argue that adoption of some of the labour standards would impose an undue burden on their countries. As the Human Resources Minister of Malaysia has pointed out, 'We certainly would not agree to reflect those [labour] standards rigidly in our legislations as this will stifle economic growth, resulting in the eventual displacement of workers' (*New Strait Times* 1995: 15). In addition, many of the countries potentially affected by such a social clause contend that the humanitarian claims are simply a guise for protectionist policies. India's former Prime Minister P. V. N. Rao stated, 'Such causes [labor standards] could become an alibi for raising protectionist trade barriers' (*Economist* 1994: 13).

Many international organizations dealing with trade issues have sided with developing countries. One of the conclusions of the World Bank's *World Development Report 1995: Workers in an Integrating World* is that 'the costs of trying to link national labour standards to international trade relations will almost certainly outweigh any benefits'. The WTO's former

Director General, Renato Ruggiero, concurred with the viewpoint, stating 'Using trade restrictions to enforce labour standards would not only be susceptible to protectionist abuse but could, by reducing their economic growth, also reduce the ability of low income countries to afford better labour standards' (*BNA Management Briefing* 1995: 12). The ILO even recognizes a serious disadvantage in using negative economic incentives in encouraging labour standards in countries. The ILO argues that, in cases such as child labour, the policy may have the 'effect of driving child labour underground, further into the shadows and into even more unregulated sectors' (*National Journal* 1995: 24).

In contrast, labour unions in industrial countries have consistently advocated a social clause linked to international trade negotiations. For example, in the United States after the release of the World Bank's *World Development Report 1995*, the American Federation of Labor and Congress of Industrial Organizations criticized the World Bank's recommendation of divorcing trade from labour market issues. On the issues of Mexico and Chile's inclusion in the North American Free Trade Agreement treaty, the American Federation of Labor and Congress of Industrial Organizations and the Canadian Labour Conference have been extremely vocal in endorsing the inclusion of various labour market regulations into the trade treaty.

The economic literature also varies widely in its opinions on the issue of incorporating a social clause into trade negotiations. Bhagwati (1995, 1996) has argued against a social clause on the grounds that proposals for such clauses are usually asymmetrically stacked against developing countries, therefore betraying a protectionist intent or design. Instead, alternative, more efficient ways of spending for better standards are desirable and should be used. Casella (1996) argues that many standards, like child labour standards, are similar to public goods, because the benefits spill over to the entire community. Therefore, differences in standards among countries reflect diverse preferences and incomes. Zhang (1994) echoes this result by showing that increased income through free trade naturally brings about higher standards in developing countries.

By contrast, Rodrik (1996) proposes the creation of a global 'social-safeguards clause', which would provide adherence to a 'widely held ethical standard or social preference'. In a similar vein, Fields (1995) calls for a distinction between labour rights, which should be required internationally because they are basic human rights, and labour standards, which should not be subject to harmonization.

Freeman (1994) takes a slightly different tack on the debate, arguing that intercountry equity can be improved by providing information to consumers about labour conditions in various countries. Informed consumers adjust their demands in accord with their taste for labour market conditions in other countries. This 'labelling' alternative, which also was suggested for environmental concerns, has received serious consideration in the US Congress, where in November 1995 Senator Tom Harkin introduced a bill to carry out such measures.

An important question raised by these debates is whether implementation of standards can have strategic benefits for industrial countries. At first, answers to this question seem to exist. One possible reason that industrial countries call for labour standards abroad is that these countries wish to artificially protect their competitiveness in labour-intensive goods that are produced industrially, such as textiles. Perhaps the less straightforward question is why, in a climate of trade negotiations, would industrial countries choose to impose industrial labour standards, which *prima facie* incur industrial costs by creating distortions in the labour market. Could the adoption of an industrial labour standard improve welfare for an industrial country through the policy's effect on the international trade market? In addition, once such a policy is instituted, what possible gains are there in encouraging the establishment of standards abroad?

This paper analyses these questions and presents mechanisms through which protectionist goals may lead an industrial country to maintain a labour standard domestically, as well as to advocate standards among its trading partners. For purposes of exposition, labour standards in industrial countries are modelled as minimum wage policies, while labour standards for developing countries (the trading partners) are represented as reductions in labour supply, for example, policies abolishing child labour, banning forced prison labour, and so forth. Brecher (1974a, 1974b) first analysed the effects of a minimum wage policy on international trade, and showed that the unilateral tariff policy of a country may be different with a minimum wage policy. This paper builds on Brecher's analysis by looking at the bilateral tariff equilibrium, that is, what happens when the trading partner reacts to the industrial country's labour standard. In the spirit of Johnson's (1953-54) tariff-war equilibrium, where both countries are worse off compared to free trade, the analysis allows for strategic interaction between countries.

2. THE BASIC FRAMEWORKS

2.1 The tariff-war model

We use a standard two-country trade model with two countries, Industrial and Developing, which have similar production and consumption structures. An asterisk (*) indicates the developing country's variables. Both countries produce two goods, cloth and computers, and the two industries use capital and labour. The factors of production are perfectly mobile between sectors within a country, but not between countries, and both economies are perfectly competitive with constant returns to scale in production. Preferences and production technologies are assumed to be well-behaved and to have standard properties. The two goods move freely between the two countries, and each country has the ability to place an ad valorem import tax.

Both countries share identical production technologies, and the industrial country is relatively capital abundant and thus imports the labour-intensive good, cloth. The developing country is relatively labour-abundant and imports the relatively capital-intensive good, computers. The countries' ad valorem tariffs on their importable good are represented by τ and τ^*. For the analysis, we assume that Developing has some ability to impact on world prices through trade.

Johnson (1953-54), updated by Mayer (1981) and Dixit (1987), showed that both countries' welfare (V, V^*) can be solved simply in terms of the tariff levels, $V(\tau, \tau^*)$ and $V^*(\tau, \tau^*)$. Industrial will set τ to optimize its welfare, given any level of Developing's tariff. A derivation of the optimal tariff reaction functions for a Cobb-Douglass production and preferences is presented in the appendix. The graphical relationship between the industrial country's welfare and the various tariff levels is indicated in Figure 1.

Indifference curves *(I)* over various tariff bundles for the industrial country are graphed with higher subscripts indicating higher levels of utility. The industrial country's tariff-reaction curve *R(τ, τ^*)* plots the optimal Industrial tariff given the other country's tariff level. If the developing country's tariff is set at zero, Industrial realizes its highest welfare possible by setting a tariff at τ_0.

FIGURE 1
INDUSTRIAL'S OPTIMAL TARIFF REACTION FUNCTION
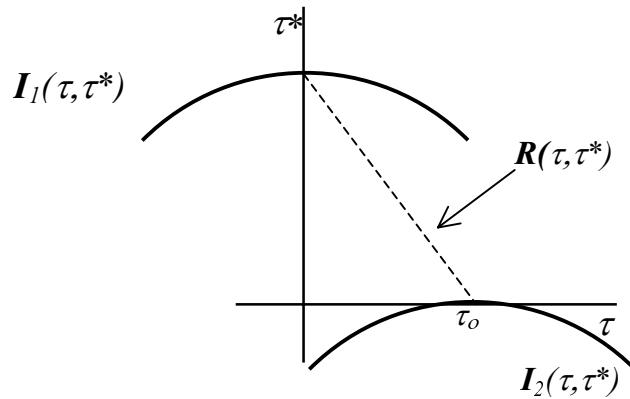
Deriving a similar tariff-reaction curve for the developing country $R^*(\tau, \tau^*)$, we can combine the two tariff-reaction curves, Figure 2, to find the Cournot-Nash[1] equilibrium of the tariff game at (τ_n, τ_n^*). At this point, both countries have reached a 'prisoner's dilemma' equilibrium. Each country, by individually attempting to improve its own terms of trade, have made world welfare worse.

FIGURE 2
COURNOT-NASH TARIFF-WAR EQUILIBRIUM

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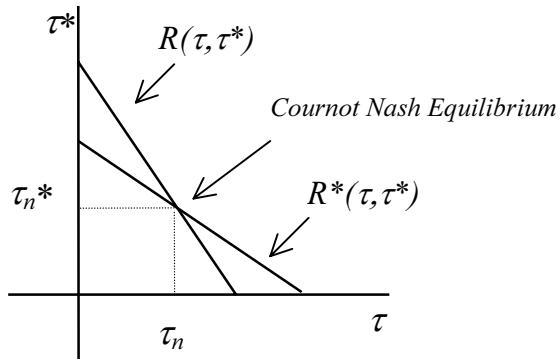
[1] A Cournot-Nash equilibria in tariffs. Although prices are set as in Bertrand Equilibria, it has an exact counterpart in quantities.

Another possible tariff equilibrium is a Stackelberg outcome, where the industrial country chooses the tariff level that maximizes its welfare along Developing's tariff-reaction curve. In Figure 3, this possibility is represented by the tariff bundle (τ_s, τ_s^*).

FIGURE 3
STACKELBERG EQUILIBRIUM
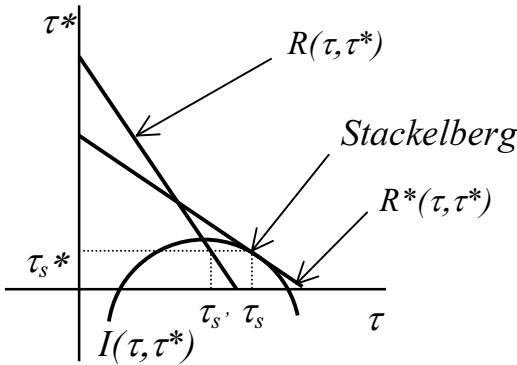
Under this outcome, Industrial's commitment to a higher tariff forces the developing country to drop its tariffs (compared to the Cournot-Nash equilibrium). At the Stackelberg point, welfare for the industrial country is higher compared with the original Cournot-Nash equilibrium. Unfortunately, because this tariff bundle is not on Industrial's reaction curve, the situation that Industrial will commit to imposing τ_s is not credible. If we assume non-Stackelberg behaviour then once the developing country has set its tariffs at τ_s^*, the industrial country will find it optimal to deviate to tariff level $\tau_{s'}$.

2.2   The minimum wage model

Labour standards in the industrial country are modelled by a minimum wage policy. The standard not only represents minimum wage policies per se, but can be interpreted as any labour market regulation that causes price rigidities in the industrial labour market, such as restrictions on hiring and firing, wage indexing, and so forth. We assume throughout that the minimum wage policy holds in both sectors of the economy and fixes the real marginal product of labour above the rate that would prevail without the policy.

As Brecher (1974a, 1974b) shows, a minimum wage in the industrial country raises the relative price of cloth and fixes the other prices in the economy, because firms must earn zero profits under perfect competition. Production of cloth declines due to the higher cost of labour. If product prices were any lower than the price implicitly set by the minimum wage, then production of both goods in the economy would not be possible. All the firms would switch to production of computers. In the international market, the minimum wage flattens Industrial's import demand curve at a price determined by the level of the wage.

Figure 4 reveals that the minimum wage raises the international price from p to p'. This increase in the world price translates into a deterioration of Industrial's terms of trade and an increase in the total quantity traded. As the minimum wage rises, the relative price in the world market increases, and the amount imported from the developing country increases.

FIGURE 4
EFFECT OF A MINIMUM WAGE ON TRADE
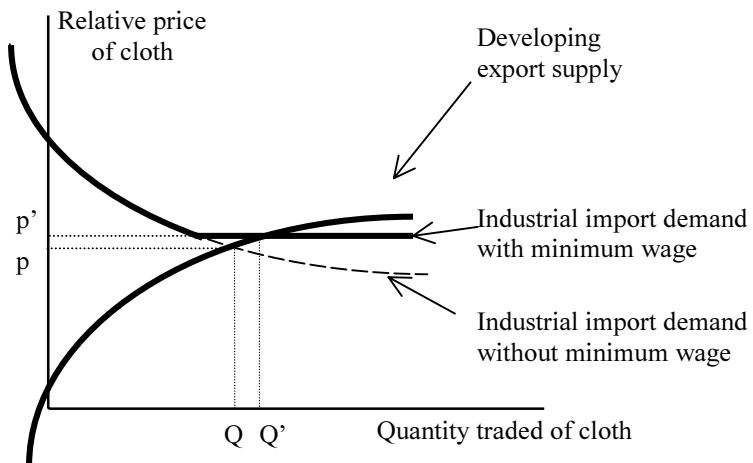
The labour standard in the industrial country, therefore, acts essentially as an import subsidy policy, increasing imports while deteriorating Industrial's terms of trade. In terms of welfare, the minimum wage policy only hurts the industrial country because it creates unemployment while simultaneously worsening the country's trade position. From a protectionist point of view, such a standard, by itself, would be completely undesirable because it decreases production of the import-competing good (cloth).

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3.   TRADE WITH A LABOUR STANDARD IN THE INDUSTRIAL COUNTRY

By introducing a distortionary minimum wage policy like the one in section 2.2 into a tariff-war situation, we fundamentally alter the international equilibrium and create a situation where the policy becomes desirable for an industrial country.

3.1   Effect of a minimum wage on industrial's tariff-reaction function

We begin the analysis by assuming that two countries are initially in the trading scenario described above in section 2.1. Because both countries have the ability to set tariffs, the countries will set tariffs in their own interests so that they are at the Johnson/Nash equilibrium. From this initial tariff-war equilibrium where no internal distortions exist, such as labour standards, we assume the industrial country implements a minimum wage.

We assume that Industrial can set its minimum wage at any level between the wage that prevails under free trade (w_F), for example, if both countries' tariff were set to zero, and the wage that prevails in Industrial under autarky (w_A). Compared to autarky, the introduction of trade will lead to a decrease in the price of cloth and a simultaneous decrease in the industrial country's wage. Thus, the autarky wage will be higher than the wage prevailing under free trade, $w_F < w_A$.

These boundaries are chosen for the minimum wage because, if it were set below w_F, the wage would not be binding under free trade, while a wage set higher than w_A would induce the country to cut off trade completely. The minimum wage is set in terms of the numeraire good, which in this case is the industrial price of the capital-intensive (exported) good in the industrial country.

Proposition 1: In the face of a binding Industrial minimum wage, the optimal response for a capital-abundant country is to set a tariff just high enough to alleviate the unemployment distortion created by the labour standard.

Proof: Because Industrial prices are fixed by the level of the minimum wage, any increase in the import tariff will increase Industrial labour demand by placing upward pressure on the shadow wage in the economy, but will not change Industrial prices. With constant prices, the

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usual consumption and production distortions caused by a tariff do not occur, so increases in the tariff reduce unemployment, but do not impose any additional costs on the economy. Therefore, the tariff will be set at a level where it is just high enough to bring about full employment in the country. At this level of the tariff, the shadow wage is equal to the minimum wage, and the minimum wage regime is just barely binding.

A tariff higher than this full employment level would not be optimal because it would raise the market wage above the level of the minimum wage, and the country would once again be back in the non minimum wage regime. Because this level of the tariff was not optimal without the minimum wage, it cannot be optimal now.

In Figure 5, we see a graphical demonstration of this proof. The minimum wage pushes production inside the production possibility frontier of the industrial country (point A). At the relative price determined by the minimum wage, $p(\overline{w})$, consumption occurs at point (a). With homothetic demand, we can also draw the consumption ray associated with these prices, $\alpha[p(\overline{w})]$.

FIGURE 5
EFFECT OF A MINIMUM WAGE ON INDUSTRIAL'S PRODUCTION
POSSIBILITIES FRONTIER
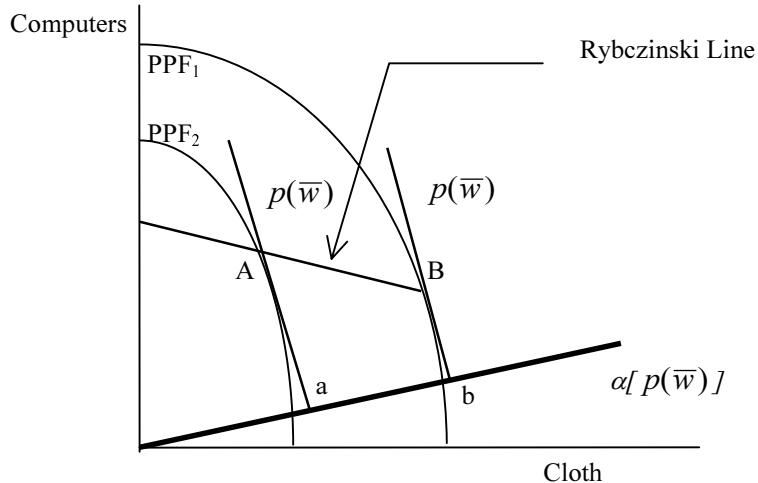
An increase in Industrial's tariff leads to a reduction in the world price for cloth and a decrease in the imports of the industrial country. As expected, the tariff creates a wedge between the industrial and world price. But now,

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because Industrial's domestic prices are fixed by the minimum wage, the tariff only leads to a reduction in the relative world price. The lower world price of cloth results in a decrease in the developing country's exports. At the same time, Industrial's relative demand for cloth remains unchanged because Industrial prices are fixed. Therefore, the industrial country compensates for the reduction in imports by increasing Industrial production of the good. A higher and higher level of the tariff shifts Industrial production and consumption until they are at points B and b, respectively.

The minimum wage causes a shift in Industrial's tariff-reaction function (Figure 6) such that in the presence of an effective minimum wage level for certain ranges of τ^*, τ is higher. If the minimum wage is set at the level w_F, the tariff-reaction function is the same as the one derived in section 2.1 above because, with any positive tariff, the policy will no longer be binding. With a minimum wage higher than this level, we have seen in proposition 1 that the optimal industrial tariff will be higher.

FIGURE 6
EFFECT OF A MINIMUM WAGE ON INDUSTRIAL'S TARIFF-REACTION FUNCTION
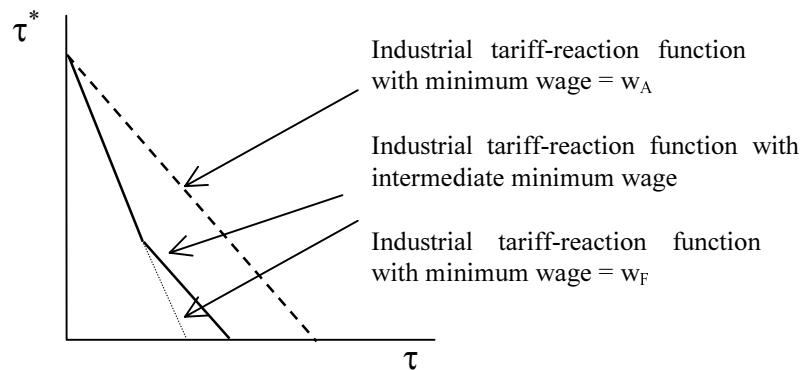
The entire tariff-reaction schedule does not necessarily change because, for any given level of the minimum wage, if the developing country tariff is high enough, Industrial's minimum wage will no longer be binding. An import tariff in the developing country decreases its own import demand for computers, while placing upward pressure on the world price of cloth. This pressure will eventually lead to enough of an increase in the industrial country's labour demand to bring Industrial out of the minimum wage regime. In this case, the optimal tariff for the industrial country is the same as it was before the labour standard. A higher and higher minimum wage

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shifts out a larger part of the industrial country's tariff-reaction function, up to the point where the minimum wage is set at w_A and the entire tariff-reaction function has been shifted out.

The most important characteristic of Industrial's new tariff-reaction function, as shown in proposition 1, is that every tariff bundle on the curve describes a situation of full employment in the economy. The section where the tariff-reaction curve 'breaks away' from the old curve describes points of full employment, with the minimum wage regime barely holding, while the section where the tariff-reaction curve is the same as the old curve describes points of full employment where the minimum wage regime is not binding. Thus, all tariff combinations to the north-west of the curve must be points of full employment as well, while combinations south-east of the curve describe situations when labour is not fully employed.

3.2   Effect of a minimum wage on developing's tariff-reaction function

To describe the new tariff equilibrium, we also need to understand how the labour standard will impact on the tariff-reaction curve of the trading partner, the developing country. In the end, an effective minimum wage will cause the developing country's optimal tariff to decline. To begin the analysis, we initially assume that Industrial's tariff is set to zero ($\tau = 0$) and then later drop this restriction. With a binding minimum wage in the industrial country, the developing country faces a perfectly flat import offer curve for cloth (similar to Figure 4).

At this point, the developing country has two options: (a) accept the minimum wage and set its own tariffs to zero ($\tau^* = 0$), thus losing any tariff revenues, or (b) place an import tariff on computers that will put upward pressure on labour demand in Industrial. If Developing's tariff is set high enough, global labour demand will be enough to bring Industrial out of the minimum wage regime. By successfully carrying out the second option, the developing country can regain its tariff revenues, but at the cost of tariff distortions internally.

Which option is chosen depends on the level of the minimum wage set in the industrial country. We can determine the chosen option by comparing Developing's welfare with and without a tariff under different levels of the minimum wage and by assuming that Industrial's tariffs are initially zero:

- If the industrial country's minimum wage is set at w_F, Developing's welfare is maximized by placing the optimal tariff that would have been set without the minimum wage ($\tau*_{opt}$). At this level of the developing country tariff, the relative price of cloth has been bid up, and the minimum wage is no longer binding.

- With higher and higher levels of the Industrial minimum wage, the terms of trade keep improving for the developing country. Finally, at some intermediate level of the minimum wage, w_I ($w_F \leq w_I \leq w_A$), the benefits from the industrial country labour standard are so high that it is optimal for the developing country to sets its tariffs to zero. At this point, the developing country's welfare is higher with a zero tariff as compared to any positive tariff.

- If the minimum wage was to be set at w_A, the world prices are fixed on the world market, and the developing country realizes a large gain in its terms of trade. In this case, Developing definitely finds it optimal to set its own tariff at zero because a positive tariff would only cause Industrial distortions and no gains from the international market.

<u>Proposition 2</u>: A minimum wage level, w_I, exists, where ($w_F \leq w_I \leq w_A$). Above this, if the industrial country's tariffs are zero, a developing country will always find it optimal to set its tariffs to zero.

<u>Proof</u>: If the minimum wage is set at the level prevailing under free trade (w_F), it is optimal for the developing country to have a positive tariff. At this level of the minimum wage and with the industrial country's import tariff set to zero, having some positive level of tariff is still optimal, because the minimum wage is not binding.

Alternatively, if the minimum wage is set at the level prevailing under autarky (w_A), it is optimal for the developing country to have a zero tariff. In this case, prices are fixed on the world market, and any positive level of tariff in Developing will only cause Industrial distortions without any tariff revenue. Therefore, some level of the minimum wage (w_I) must exist between w_F and w_A where the optimal developing country tariff moves from a positive level to zero.

The effect of different levels of Industrial's minimum wage on the developing country's welfare is shown in Figure 7, assuming that the

industrial country's tariffs are set to zero. The curve labelled V^*_0 is Developing's welfare without a minimum wage. This situation has an optimal Developing tariff, which is indicated by τ^*_{opt}. For tariff levels greater than and less than τ^*_{opt}, welfare must be declining.

Curve V^*_A is a little trickier. It represents welfare for the developing country if the minimum wage in the industrial country is set at the wage level prevailing in autarky (w_A), and it assumes that the labour standard is always binding. We know that it is impossible for the wage always to bind because high enough levels of the Developing tariff will be able to pull Industrial out of the minimum wage regime. The welfare curve is monotonically decreasing because any increase in the developing country tariff will only lead to Industrial distortions. Similarly, V^*_I and V^*_F are welfare for the developing country with the minimum wage set at w_I and with a minimum wage set at w_F, respectively. These welfare curves are always below V^*_A because the terms-of-trade benefits from the minimum wage are strictly lower as the minimum wage declines.

FIGURE 7
THE DEVELOPING COUNTRY'S WELFARE LOCUS WITH DIFFERING
LEVELS OF THE INDUSTRIAL COUNTRY'S MINIMUM WAGE

Key:

V^*_A = Developing welfare if Industrial's minimum wage is set at w_A

V^*_I = Developing welfare if Industrial's minimum wage is set at w_I

V^*_F = Developing welfare if Industrial's minimum wage is set at w_F

V^*_0 = Developing welfare if no Industrial minimum wage
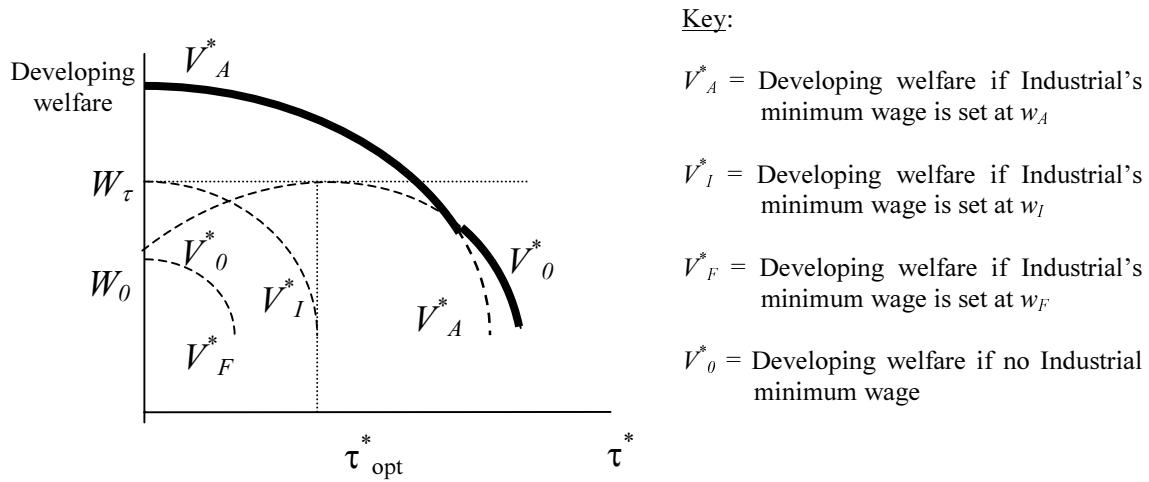
The actual developing country welfare contour, for any given level of the minimum wage, is the maximum of the welfare contour with the labour standard and V^*_0. For example, if the minimum wage is set at w_A, the actual welfare contour is the darkly pencilled parts of the two welfare contours. We see that if the wage is set at w_F, it is optimal for the developing country

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to set its tariff at τ^*_{opt} because welfare at this point (W_τ) is greater than if the tariff is set to zero (W_0). If the minimum wage is set at a level greater than w_I, though, it becomes optimal for Developing to set its tariffs at zero.

We will now see how Developing's welfare contours change if the Industrial tariff is now increased from zero. Figure 8 illustrates two points: (a) with no minimum wage in the industrial country, the impact of an increased Industrial tariff on the welfare of the developing country and (b) the same effect if we assume a minimum wage. With no minimum wage in the industrial country, the welfare contour for the developing country (V^*_0) shifts down to $V^*_{0'}$ as the industrial country's import tariff increases. The higher import tariff reduces demand for the developing country's exportable good and thus reduces welfare.

In addition to this pure tariff effect, if we now assume a minimum wage exists in the industrial country, a higher Industrial tariff also means the benefits of the minimum wage to the developing country decline because the terms of trade become worse. A higher Industrial tariff induces the developing country, in its own interest, to increase its own import tariff to a positive tariff, which will pull the industrial country out of the minimum wage regime. Thus, the developing country's welfare locus, given any arbitrary minimum wage level, would shift down as well, from V^*_w to $V^*_{w'}$.

FIGURE 8
EFFECT OF AN INCREASE IN INDUSTRIAL'S TARIFF ON DEVELOPING'S
WELFARE LOCUS

Key:

$$V^*_0 \ = \ V^* | \ w<w_F, \ \tau=0$$

$$V^*_{0'} \ = \ V^* | \ w<w_F, \ \tau>0$$

$$V^*_w \ = \ V^* | \ w=w_F, \ \tau=0$$

$$V^*_{w'} \ = \ V^* | \ w=w_F, \ \tau>0$$

The minimum wage exists only if:
$w_F = w = w_A$.
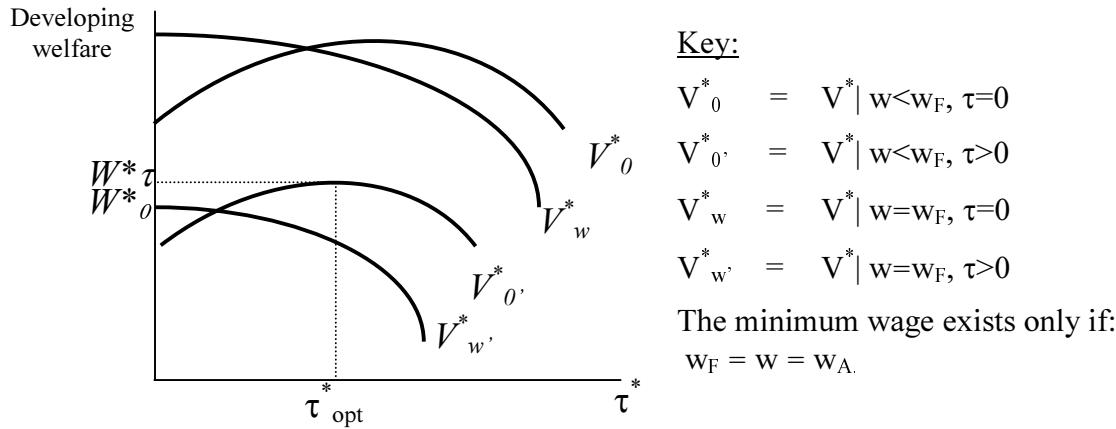
As drawn, the higher Industrial tariff induces the developing country to switch back to a positive tariff ($\tau^*_{opt'}$). This positive tariff level gives a

higher welfare level (W^*_τ), compared with its welfare if it kept its tariffs at zero (W^*_0). Thus, if initially the minimum wage is set at some level where a zero Developing tariff is optimal, eventually, as the Industrial tariff increases, the developing country will once again find it optimal to switch back to a positive level of tariff.

Proposition 3: If the minimum wage in the industrial country is set so that $\overline{w} \in [w_I, w_A)$, the tariff-reaction function for the developing country will be discontinuous.

Proof: Pick some level of the minimum wage between w_I and w_A. We know from proposition 2 that initially, if the Industrial tariff is zero, the optimal Developing tariff will also be zero. As the Industrial tariff increases, at some point, the developing country will once again find it optimal to place a positive tariff, making the reaction function discontinuous. Suppose not: the industrial country could then keep increasing its tariff, and the developing country would always find it optimal to keep its tariff at zero. At some point, the Industrial tariff will be large enough to pull the industrial country out of the minimum wage regime because the relative demand for the labour-intensive good (cloth) becomes so large. Without the minimum wage binding, the developing country still finds it optimal to have a zero tariff. This is a contradiction.

We then redraw the developing country tariff-reaction function (Figure 9), assuming a minimum wage in Industrial such that $\overline{w} \in [w_I, w_A)$. Initially, the optimal Developing tariff will be zero if the Industrial tariff is equal to zero. Eventually, though, once the Industrial tariff is large enough, the developing country will find it optimal to jump back to its old tariff-reaction function.

FIGURE 9
THE DEVELOPING COUNTRY'S TARIFF-REACTION FUNCTION

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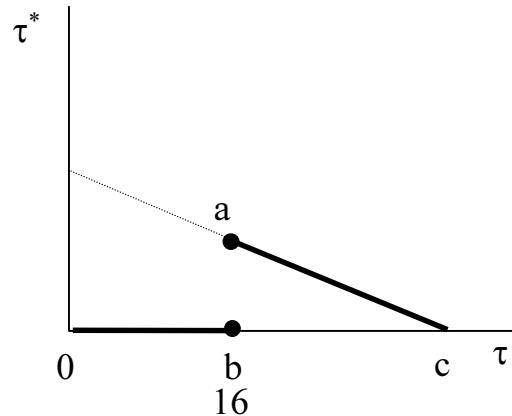
The dashed line indicates the original tariff-reaction function. At the discontinuity, points (a) and (b) provide the developing country the same level of utility, for example, the country is indifferent between two very different states of the world. At point (b), the minimum wage is binding, and the developing country tariff is set to zero. At point (a), Developing has a positive tariff and has managed to raise relative world prices of cloth so much that the minimum wage is no longer binding in the industrial country.

The shape of the Developing reaction curve is then determined. It must have this breakpoint, but where the break occurs depends on the level of the minimum wage. If the minimum wage is set equal to w_I, the smallest level of the minimum wage for which Developing's curve is discontinuous, the break will occur at the origin. As the minimum wage increases towards w_A, the flat portion becomes bigger and bigger, and the break occurs closer and closer to point (c). If the minimum wage is less than w_I, the tariff-reaction function will not change, because any tariff combination on the tariff-reaction function is sufficient to raise Industrial labour demand and to make the minimum wage non binding.

The discontinuity in Developing's tariff-reaction function is a direct result of the elbow or 'kink' in Industrial's import demand function (Figure 4). This kink occurs due to the assumptions that Industrial and Developing's goods are perfect substitutes for each other and that firms have zero profits because of perfect competition.

3.3   New tariff equilibrium

Having derived the shapes of the reaction functions with a minimum wage, we now determine the new tariff equilibrium. Because the reaction functions change under different levels of the minimum wage, we concentrate on the circumstances where the minimum wage is set between the level w_I and w_A . We focus the investigation for this range of the minimum wage, because, as discussed above, when the wage is set below the level w_I, the tariff-reaction functions do not change. Therefore, we will always get back the old Johnson tariff-war equilibrium.

Proposition 4: If the minimum wage in the industrial country is set so that $\overline{w} \in [w_I, w_A]$, only one of three possible equilibria can occur (Figure 10).

FIGURE 10
POSSIBLE TARIFF EQUILIBRIA

Equilibrium 1:
Johnson

Equilibrium 2:
"Knife-Edge"

Equilibrium 3:
Degenerate
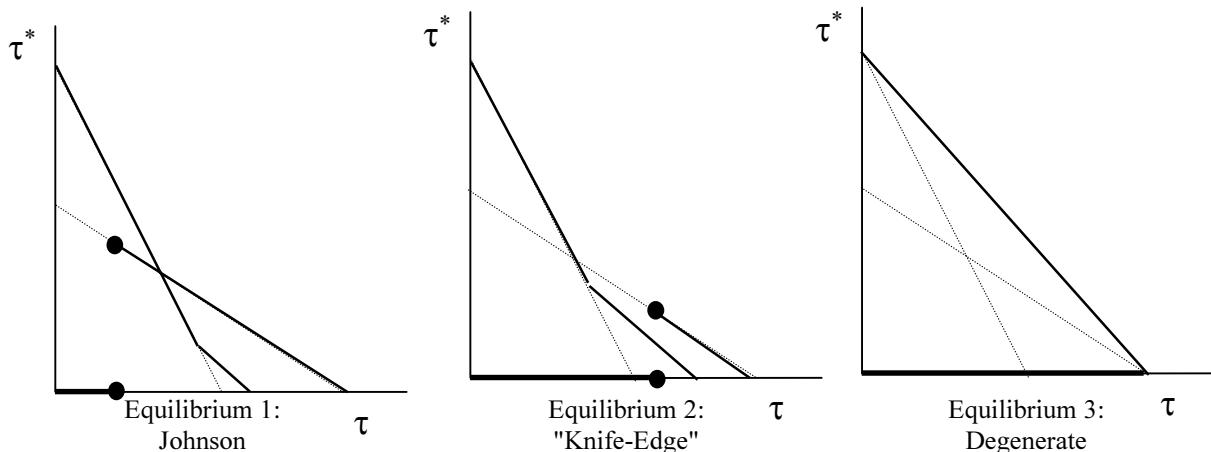
Proof: We are able to rule out all other possible types of equilibria by using two important characteristics of the reaction curves. First, the Industrial reaction function always describes a situation of full employment, and second, at the break of the Developing reaction function, utility must be the same at both levels of the tariff. The formal proof is provided in the appendix.

In Figure 10 above, the old tariff-reaction functions, the ones that would occur in the absence of the minimum wage policy, are also drawn with a dotted line. Equilibrium 1 describes a situation where the tariff reactions do not alter very much because the minimum wage is not set very high above w_I. Thus, for certain values of the minimum wage, we should always get back the old Johnson equilibrium.

We call equilibrium 3 the degenerate equilibrium. This equilibrium occurs only if the minimum wage is set at the level w_A, for example, at the wage that prevails under autarky. In this case, the optimal Developing tariff is always zero, and the Industrial tariff is set so high that all trade is cut off.

We are most interested in equilibrium 2 because it is the one where the Industrial reaction function intersects the Developing reaction function through the discontinuity. The equilibrium, in this case, is a 'knife-edge' solution, which is known more formally in the literature as a mixed-strategy Nash solution. From Figure 11, we can see that the developing country, if Industrial places the tariff τ_e, can choose between two radically

different tariff options, τ^*_h and τ^*_0. Because both options give equivalent levels of welfare, Developing is indifferent between them or in even choosing an option that gives a positive probability to either of them occurring.

FIGURE 11
KNIFE-EDGE TARIFF EQUILIBRIUM
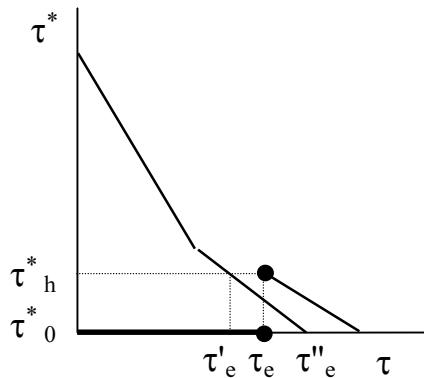
The industrial country, by contrast, reacts in the following way. If Industrial knows Developing will set its tariff at τ^*_h, Industrial's optimal tariff would be τ'_e . However, if Developing were to play τ^*_0, Industrial would set its tariff at τ''_e. In this sense, no single 'best reaction' to the tariff exists. In order for Industrial to choose τ_e, Developing must play a combination of the two tariffs, for example, play either tariff with a positive probability. Although all three of the equilibria listed above are possible, from simulations we found that the 'knife-edge' equilibria is the one that is most prevalent over a wide-range of minimum wage values above w_I.

One could argue that the one-shot nature of the tariff game with a mixed-strategy equilibrium stretches the plausibility of the model for two reasons. The first argument is that tariff policies are not set in developing countries by flipping a coin. One interpretation for the seemingly random nature of Developing's actions in the knife-edge equilibria comes from Harsanyi (1973). Developing's tariff policy is a manifestation of the idea that the industrial country has incomplete information about the variables that affect Developing's decisionmaking. For our case, the uncertainty can arise for a number of reasons. For example, Industrial may be unsure exactly how much weight the other country places on the welfare of their labour,

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what the current political situation is in the developing country, or even how Developing makes its decisions on tariff policy.

Any of these cases of incomplete information can be translated into uncertainty about how Developing will react to Industrial's tariff and thus uncertainty in the welfare. In other words, the complete information game where Industrial knows with what probability the developing country will play a high tariff versus a low tariff can be translated into a game where Industrial has incomplete information and is unsure of Developing's type. Harsanyi (1973), along with a later extension by Milgrom and Weber (1986), showed that it is not even necessary for Industrial to have prior knowledge on the probability of the type of country it is facing. For a rich enough strategy space, the mixed-strategy Nash game can almost always be thought of as the convergence of a series of pure strategy games with incomplete information.

A second argument against the plausibility of the game is that we do not witness countries constantly switching between tariff regimes. Although changes in tariff rates are usually made over a couple of years, evidence exists that countries can significantly alter between high tariff and low tariff regimes as internal political economy variables change. To reproduce reality a little more effectively then, we could redefine the above game into a dynamic context where tariff policy is reset every couple of years. A subgame perfect equilibrium of this game would be one where the one-stage Nash is repeatedly played, and in some years Developing plays a high tariff and in some years a low tariff. Industrial's tariff would remain constant, and all the welfare effects of the next section would go through.

3.4 Welfare in the knife-edge equilibrium

When investigating the welfare implications of the different equilibria, welfare for the two countries in Equilibrium 1, where we get back the old Johnson tariff-war solution, is the same as if the minimum wage policy were never established. Although the minimum wage changes the tariff-reaction functions of both countries to a certain extent, the relevant parts of the tariff-reaction curves are not affected, so the original equilibrium is not altered.

Similarly, welfare in Equilibrium 3, where the minimum wage in the industrial country is set at the wage level prevailing in autarky, is the same as welfare for both countries in autarky. At this level of the minimum

wage, the industrial country places a tariff that completely halts all trade in the world market. Therefore, prices in the Industrial economy and the Developing economy due to the tariff are now at the same level as they were in autarky for both countries.

Welfare for Equilibrium 2, the knife-edge case, is a bit harder to calculate. In this case, the developing country will randomize between two different tariff levels, τ^*_h and τ^*_0, given a fixed level of the Industrial tariff, τ_e. Because Developing's utility for both tariff options is exactly the same, any mixture of the tariffs will also give the same level of welfare. Equilibrium occurs, though, when the randomization the developing country chooses makes τ_e the solution to the industrial country's maximization of expected utility.

Formally, equilibrium occurs when the developing country plays a positive tariff (τ^*_h) with probability ρ and a zero tariff (τ^*_0) with probability ($1 - \rho$), such that the randomization fulfils the following condition:

$$\tau_e \in \operatorname*{argmax}_{\tau} \rho V(\tau, \tau^*_h; \overline{w}) + (1 - \rho)V(\tau, \tau^*_0; \overline{w})$$

In the expression, $V(\tau, \tau^*; \overline{w})$ represents Industrial's welfare, which, as before, depends on τ and τ^* with both of these tariffs conditional on the level of the minimum wage. Because the two different tariff levels for the developing country, τ^*_h and τ^*_0, are both played with positive probability ($\rho > 0$), we must analyse Industrial's expected welfare rather than simply its welfare under the expected tariff.

Proposition 5: A small increase in the minimum wage of the industrial country, which moves the tariff equilibrium from the old Johnson tariff-war situation to the new knife-edge solution, may improve welfare for the industrial country.

Proof: A more formal proof is presented in the appendix. We start with the minimum wage at a level where the Johnson equilibrium is barely holding, for example, an epsilon increase in the minimum wage pushes the equilibrium into the mixed-Nash (knife-edge) situation. Expected utility is:

$$EU = \rho(\overline{w}) \, V(\tau, \tau^*_h; \overline{w}) + (1 - \rho(\overline{w})) \, V(\tau, \tau^*_0; \overline{w})$$

and we are barely at the point where $\rho(\overline{w}) = 1$. We totally differentiate this equation and employ an envelope-condition argument to show our result (subscripts represent derivatives with respect to that variable):

$$d(EU) = \left\{ \underline{\rho_{\overline{w}}\left[V(\tau, \tau_h^*; \overline{w}) - V(\tau, \tau_0^*; \overline{w})\right]} + \underline{\underline{\rho V_{\tau^*} \frac{d\tau_h^*}{dw}}} + \underline{\underline{\underline{\rho V_\tau \frac{d\tau}{dw} + (1-\rho)V_\tau \frac{d\tau}{dw}}}} + \underline{\underline{\underline{\underline{V_{\overline{w}}}}}} \right\} d\overline{w}$$

$$(-) \qquad\qquad\qquad\qquad (+) \qquad\qquad (0) \qquad\qquad (-)$$

The terms in the equation are as follows:

- The first term (underlined once) is always negative and represents the (now) positive probability that there will be unemployment in the industrial country and that welfare will decline. By increasing the minimum wage, the possibility that the developing country will place a zero tariff increases from zero to some small positive amount. With a zero tariff, though, the industrial country is below its tariff-reaction function, and the country has unemployment in the Industrial market.

- The second term (underlined twice) is always positive and represents the improvement in Industrial's welfare due to the reduction of Developing's tariff.

- The third term (three underlines) represents the change in welfare due to the increase in Industrial's tariff. This term is negative if τ is greater than the optimal tariff. By the envelope theorem, though, the term will be close to zero for small changes in the minimum wage.

- The final term (four underlines) is also negative and is the direct (unemployment) loss in welfare from a minimum wage policy.

Thus, a small increase in the minimum wage from the Johnson equilibrium may improve welfare for the industrial country. In simulations with Cobb-Douglas demand and production, the change in expected welfare always seems to come out as positive, for example, the second term dominates the other terms.

The welfare improvement derives from the fact that the minimum wage moves the industrial country closer to the Stackelberg point on Developing's reaction function. Even though the increase in the minimum

wage causes additional employment distortions industrially, for small increases it primarily acts as a commitment device to achieve the Stackelberg equilibrium, which forces an increase in the Industrial tariff and a subsequent decline in Developing's tariff.

Using the terminology introduced by Bulow, Geanakoplos and Klemperer (1985), the introduction of the standard has both a direct and a strategic effect on Developing's welfare. The direct effect is to increase unemployment. The strategic effect though raises Industrial's tariff while reducing Developing's tariff. The strategic effect of the standard is the most interesting result for this paper because Industrial by implementing a policy unrelated to trade considerations, is actually able to affect tariffs in a more protectionist fashion while possibly improving welfare.

Dropping the assumption that Industrial and Developing are relatively similar in size does not alter the outcome of the tariff game. Because we are working in a two-country framework, both countries will have some degree of market power in the world market. A symmetric and equivalent formulation for this game would be to let the developing country set a minimum rental rate of capital. The effects of such a policy would create an advantage for the developing country. The surprising result of the model is that the minimum wage, a purely distortionary policy, may actually serve to improve Industrial's welfare in the face of a tariff-war situation. By implementing legislation in the Industrial factor arena, the industrial country is able to determine the outcome in the international policy arena as well. Thus, the institution of the standard for humanitarian purposes can actually serve to improve the country's welfare along tariff lines.

Similar to the Brander-Spencer type models of strategic trade interventions, the industrial country in this case has the option of intervening in Industrial factor markets to achieve improvements in the international trade market. Although the labour standard may not necessarily be implemented for purely protectionist reasons, the outcome of the policy for the industrial country is quite clear. The minimum wage policy is able to increase the wage of labourers, raise import tariffs, increase production in the import-competing sector, maintain full employment, reduce the tariffs of the developing country, and improve Industrial's welfare.

4. TRADE WITH A LABOUR STANDARD IN BOTH COUNTRIES

Until now we have examined the situation where the industrial country imposes the labour standard while the trading partner does not. Many times in the current political climate, industrial countries have insisted through the WTO that a core set of labour standards be implemented abroad as well. This section models a possible reason why the industrial country would encourage such a policy.

Typically, this effect is explained in a non-tariff environment by showing that the labour standard in a developing country will improve the welfare of the industrial country's labour force, but will reduce the overall welfare of the industrial country and will reduce the global welfare as well. This section puts forward a mechanism by which the industrial country's insistence on standards abroad results in an increase in overall welfare for the Industrial. The setup for the second part of the model takes section 3 as given. We imagine a situation where the countries have already engaged in a tariff war and the industrial country has implemented a welfare-optimizing minimum wage policy. We now introduce to this framework an institution like the WTO, which has the goal of reducing tariffs or at least constraining them to the levels currently prevalent. The explicit constraint on tariff levels will prevent the industrial country from alleviating the distortion caused by the minimum wage solely through industrial tariff policies. By contrast, a labour standard in the developing country could achieve the same goal as the industrial tariff policy. Thus, as a prerequisite to entering WTO-type tariff negotiations, the industrial country, recognizing that such negotiations will lead to Industrial unemployment, demands international labour standards.

Rather than calling for labour standards abroad, the industrial country's first-best option to alleviate unemployment would be to dismantle the minimum wage policy—the source of the domestic distortion. This could be achieved through a production tax along with a subsidy, as Brecher (1974b) points out. We assume though that, due to internal pressure or because of international regulations on production subsidies, the reversal of such a policy would be impossible. In the absence of a minimum wage at home, a labour standard in the developing country provides no benefit to the industrial country, because the policy would not only reduce world welfare, but would also deteriorate Industrial's terms of trade and its exports (Brown, Deardorff, and Stern 1996).

The most symmetric method of modelling Developing's labour standard would be to have the developing country implement a minimum wage as well. The difficulty in using this approach is that two possible outcomes could occur. With the minimum wage in the industrial economy, the world equilibrium is achieved when prices in both countries are equalized at the levels set by the labour standard. From this set of prices, if the developing country now sets a binding minimum wage, which must by assumption be larger than the minimum wage in the industrial country, both countries actively are fixing the world price at two different levels. In this case, trade where both countries have diversified production of both goods is no longer possible.

Alternatively, Developing could set a non binding minimum wage or a minimum wage at the same level as the industrial country. In this case, both countries can produce both goods, but multiple equilibria are possible. Both these cases, while interesting possibilities, give a type of degenerate solution.

In consideration of this difficulty, we instead model the implementation of the standard in Developing by assuming that the legislation in effect reduces the labour supply of the country. For example, one of the labour standards currently in discussion is the exploitation of child labour. If a developing country were to impose such a standard, the primary effect would be to reduce the developing country's labour supply. In this case, because only quantities are controlled rather than an additional price, a unique solution to the problem can still be found.

Analytically, we introduce the policies of the WTO as a restriction on the maximum tariffs allowable by both countries. The tariff limit is set at the levels currently prevalent in the world economy. From section 3, we have seen that the Industrial's tariff will always be set at the level τ_e (Figure 10), which is determined by the level of the minimum wage. The developing country's tariff, on the other hand, can be at either τ^*_h or τ^*_0. The analysis will focus on the situation where the developing country has set its tariffs at τ^*_h. As we will see, with the WTO restriction, the case where the tariff is set at τ^*_0 gives exactly the same conclusions.

With the tariff combination, (τ_e, τ^*_h), no unemployment exists in the industrial economy because the tariffs are high enough to pull the economy out of the minimum wage regime. With the WTO constraints, the tariff-reaction functions for the two countries will once again change. In Figure 12, the dashed lines indicate the tariff-limit levels. For levels of the

developing country's tariff below τ^*_w, the industrial country would like to set a tariff higher than the WTO limit, but is not allowed to do so. Thus, Industrial's reaction for these tariff levels stays constant at τ_e. By contrast, Developing's tariff-reaction function remains unchanged by the restrictions.

FIGURE 12
RESTRICTIONS ON TARIFF SETTING
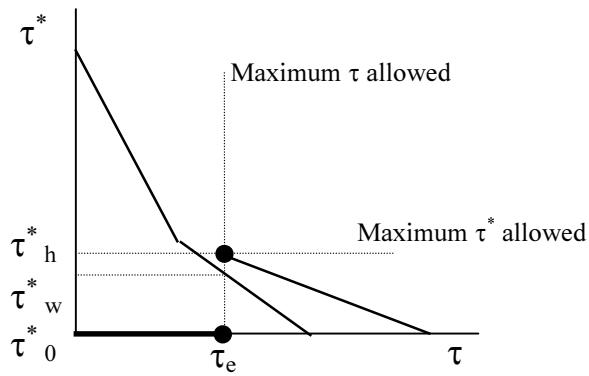
Proposition 6: With a restriction on the maximum tariff levels allowable, the new tariff equilibrium will occur at a point of unemployment for the industrial country.

Proof: We use Figure 13 as a graphical demonstration of this proposition. The intersection of the newly altered tariff-reaction functions occurs when Industrial sets its tariffs at τ_e and Developing drops its tariffs to zero. Because this tariff combination is below Industrial's 'unconstrained' tariff-reaction function, it represents a point of unemployment for the Industrial economy.

FIGURE 13
TARIFF REACTION FUNCTION WITH TARIFF RESTRICTIONS

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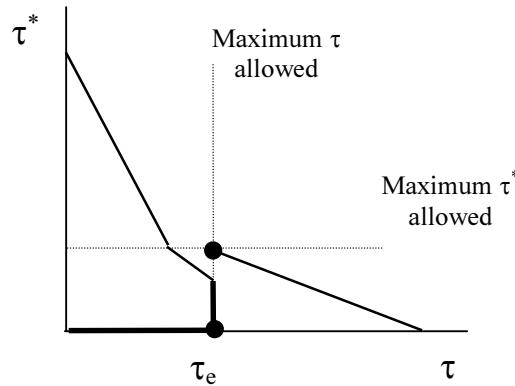
A WTO restriction on tariffs would precipitate a change in tariff policies, which in turn results in unemployment for the industrial country. Under this new tariff regime, the minimum wage policy, which before was a source of welfare improvement, now reveals its distortionary characteristics. Because the industrial country by assumption is unable to dismantle the policy, it finds that an alternative method of avoiding the unemployment loss is to require a labour standard in the developing country as well. A reduction in Developing's labour supply will cause a reduction in Developing's exports of the labour-intensive good. At fixed world prices, this reduction in trade leads to an increase in Industrial's production of the import-competing good, as well as an increase in labour demand and thus an improvement in employment and welfare.

The Developing labour standard acts essentially as a second-best policy to alleviate the distortion of the minimum wage industrially. Davis (1996) shows an analogous result but in reverse where increases in the labour supply in the developing country lead to greater unemployment in the industrial country.[2] Because Industrial no longer has tariffs available as a policy tool for securing welfare improvements in the face of a minimum wage policy, Industrial finds it optimal instead to require a labour standard abroad.

The call for labour standards adoption universally through the WTO, although they may inherently contain a humanitarian motive, could also be seen as a way for industrial countries to escape the unemployment that would ensue if tariff restrictions were carried out. This is one possible mechanism through which the universal call for labour standards adoption may simply be a means for ensuring protection of the industrial country's import-competing sector.

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[2] Don Davis (1996) has also pointed out that the reduction in Home's unemployment is a consequence of the two goods, two countries nature of the model. If either country has a good that is produced only domestically, or there are factors which are fixed within sectors, then it is possible that the reduction in Foreign's labour may actually result in an increase in Home's employment. As long as there is complete diversity in production across countries, and factors are also mobile between industries, the results in the paper will hold.

5.   CONCLUSION

This paper has shown how a country's labour policies can radically change the international tariff equilibrium. By introducing a labour standard, an industrial country can improve welfare through the policy's effect on industrial and developing countries' tariff positions. The standard effectively acts to increase the industrial country's optimal tariff on its labour-intensive imports (cloth) while forcing the trading partner to drop its own tariffs, thereby moving the industrial economy closer to an optimal Stackelberg tariff. The surprising result of the model is that the minimum wage, an otherwise purely distortionary policy, may improve an industrial country's welfare in the face of a tariff-war situation.

Furthermore, labour standards adoption is encouraged in the developing country when multilateral trade agreements limit the use of traditional trade tariffs. By securing a reduction in the labour force of the developing countries, the industrial countries can prevent unemployment, and thus welfare losses, in their own countries. Therefore, arguments for global labour standards, while perhaps motivated by a moral stance, can easily be subverted by more protectionist interests. An implication for policy discussions is that an argument does exist which indicates labour standards can be viewed as disguised protectionism.

In contrast to the 'new' strategic trade theory, where government intervention through imperfect product markets leads to improvements in a country's welfare, this paper finds that intervention into imperfect factor markets can result in welfare improvements. Labour standards are thus 'second-best' strategic trade policy tools, which have the added advantage of being instituted in the developing country while appearing under a humanitarian guise.

6.   APPENDIX

A. Derivation of optimal tariffs

In this section, we derive the model showing what the shapes of the tariff-reaction functions will be without a labour standard. From the text, we

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know the production and consumption structures of the two countries are assumed to be similar. Each country produces two goods:

(1) $Y = Y(K^y, L^y)$

(2) $X = X(K^x, L^x)$

where K^x = Capital allocated to the X sector

K^y = Capital allocated to the Y sector

L^x = Labour allocated to the X sector

L^y = Labour allocated to the Y sector

The production of good X is relatively labour intensive, compared to good Y, implying that the capital to labour ratio in X production ($\kappa^x = K^x/L^x$) will be lower than the capital to labour ratio for Y (κ^y). We assume that the production functions have standards properties, i.e. they are both twice-continuously differentiable and strictly monotonically increasing in their respective variables. Letting the price of good Y be the numeraire ($p^y = 1$), the zero-profit conditions in both industries guarantee that factor payments will exhaust revenues:

(3) $wL^y + rK^y = Y(K^y, L^y)$

(4) $wL^x + rK^x = p(1 + \tau)X(K^x, L^x)$

where p is the relative price of good X ($p = p^x/p^y$) and τ is the ad valorem tariff placed on the importable good. Perfect factor mobility implies that factor prices across sectors are equalized while constant returns to scale assures that capital to labour ratios (κ) are simply functions of wages and the rental rate of capital.

(5) $\kappa^x = \kappa^x(w/r)$

(6) $\kappa^y = \kappa^y(w/r)$

In addition, there is a fixed amount of both capital ($\overline{K}$) and labour ($\overline{L}$) available in the economy.

(7) $K^x + K^y = \overline{K}$

(8) $L^x + L^y = \overline{L}$

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Consumers own labour and capital and demand goods X and Y by maximizing a Cobb-Douglas utility function:

$$U = X^{\zeta} Y^{1-\zeta} \qquad \text{subject to} \qquad p(1+\tau)X + Y = w\overline{L} + r\overline{K}$$

This maximization problem generates the standard demand functions for the goods:

(9) $D^x = \dfrac{\zeta \, [w\overline{L} + r\overline{K}]}{p(1+\tau)}$

(10) $D^y = (1-\zeta)[w\overline{L} + r\overline{K}]$

A similar set of equations can be written for the Foreign country, with asterisks (*) representing the Foreign variables:

(1) $Y^* = Y^*(K^{y*}, L^{y*})$

(2) $X^* = X^*(K^{x*}, L^{x*})$

(3) $w^* L^{y*} + r^* K^{y*} = p^{y*}(1+\tau^*)Y^*(K^{y*}, L^{y*})$

(4) $w^* L^{x*} + r^* K^{x*} = p^{x*} X^*(K^{x*}, L^{x*})$

(5) $\kappa^{x*} = \kappa^{x*}(w^*/r^*)$

(6) $\kappa^{y*} = \kappa^{y*}(w^*/r^*)$

(7) $K^{x*} + K^{y*} = \overline{K}^*$

(8) $L^{x*} + L^{y*} = \overline{L}^*$

(9) $D^{x*} = \dfrac{\zeta \, [w^* \overline{L}^* + r^* \overline{K}^*]}{p^{x*}}$

(10) $D^{y*} = \dfrac{(1-\zeta)[w^* \overline{L}^* + r^* \overline{K}^*]}{p^{y*}(1+\tau^*)}$

The price of the capital-intensive good in the Domestic country is still set as the numeraire. The model is closed by assuming world demand for good X equals world supply and that product prices are equalized by trade. If we assume functional forms for the production functions, we can solve for the levels of the endogenous variables (p, w, r, K^x, K^y, L^x, L^y, w^*, r^*, K^{x*}, K^{y*},

L^{x*}, L^{y*}). The equations of the model are independent and the Jacobian matrix describing total derivatives with respect to the exogenous variables is of full rank.

For our analysis we are concerned with changes in the levels of these variables, to see how changes in the tariff levels affect the welfare of the country. Similar to Mayer (1981) we utilize indirect utility functions. Since all consumers are assumed to have similar preferences we can compose Domestic's indirect welfare function, $V(p,I)$, where $I = pX + Y + \tau\pi M^x$ and is the total income of the country.

Prices are equalized across the two countries by the following equations.

(11) $p^x/p^y = p = (1 + \tau)p^{x*}$

(12) $p^{y*} = (1 + \tau^*)p^y = (1 + \tau^*)$

and the relative world price of the two goods is:

(13) $p^{x*}/p^y = \pi$

Totally differentiating the indirect utility function and utilizing Roy's Theorem, $D^x = -V_p/V_I$, and the fact that $pdX + dY = 0$ along the production possibility frontier without any domestic distortions, we find:

(14) $dV = V_I\left[-M^x d\pi + \tau\pi dM^x\right]$

Where M^x is the imports of X by the domestic country. Following Jones (1965), imports in both countries are assumed to be functions of the world price and their own tariffs:

(15) $M^x = M^x(\tau, \pi)$ $\qquad\qquad$ $M^x_\tau < 0$ and $M^x_\pi < 0$

(16) $M^y = M^y(\tau^*, \pi)$ $\qquad\qquad$ $M^y_{\tau*} < 0$ and $M^x_\pi > 0$

A domestic tariff in either country leads to a decline in their own imports while an increase in the relative world price of good X, decreases Domestic's imports and increases Foreign's. In addition, with no inter-temporal borrowing allowed in the model, trade must be balanced.

(17) $\pi M^x = (1 + \tau^*)M^y$

Totally differentiating equations (15) through (17), we solve for $d\pi$, dM^y and dM^x in terms of $d\tau$ and $d\tau^*$, and substitute these expressions into the indirect utility function of equation (14).

(18) $dV = V_I \left[\delta \left(1 + \tau - \tau \varepsilon^* \right) d\tau + \phi \left(1 + \tau \varepsilon \right) d\tau^* \right]$

where $\delta > 0$ and $\phi < 0$ represent large expressions, and $\varepsilon_\pi = -\left(\pi / M^x \right) \left(\partial M^x / \partial \pi \right) > 0$ is the price elasticity of domestic imports, while $\varepsilon_\pi^* = \left(\pi / M^y \right) \left(\partial M^y / \partial \pi \right) > 0$ is the price elasticity of Foreign imports. Using this expression we can map the indifference contours of the domestic country's welfare with respect to different tariff levels. To find the Domestic's optimal tariff reaction curve, given the level of tariffs in the other country, we set $dV/d\tau = 0$ and solve for the domestic tariff. In this case, we see that:

$$\tau_{optimal} = \frac{1}{\varepsilon_\pi^* - 1}$$

Symmetrically, we can derive Foreign's welfare function to find that it declines with an increase in Domestic's tariff, while welfare is optimized at the following level:

$$\tau_{optimal}^* = \frac{1}{\varepsilon_\pi - 1}$$

B. Proof for proposition 4

In this section, we show that given the shapes of the tariff-reaction functions, the only possible equilibria are the ones mentioned in the main text. Aside from the equilibria in the main text, we can conjecture what other possible tariff-equilibria could look like. All the possible cases for a pure strategy equilibrium are drawn in Figure 14.

We go through each of the cases to prove that each equilibrium as drawn is not possible.

Case A: Intersection at zero Developing tariff

Because point (a) is on the Industrial reaction function, it must be a point of full employment. If that is so, any increase in the Industrial tariff, keeping the Developing tariff at zero, will also be points of full employment, and the minimum wage will still not be binding. However, if the minimum wage is not binding, it is optimal for Developing to have a non zero tariff. Point (a) cannot be an optimal best response for both countries.

Case B: Intersection at bottom break point

At point (b), we once again have full employment and the minimum wage barely binding. However, from the derivation of the Developing reaction function, point (c) must give the same level of welfare to Developing as (b). That means if Developing places the higher tariff, it will receive no

FIGURE 14
IMPOSSIBLE TARIFF EQUILIBRIA
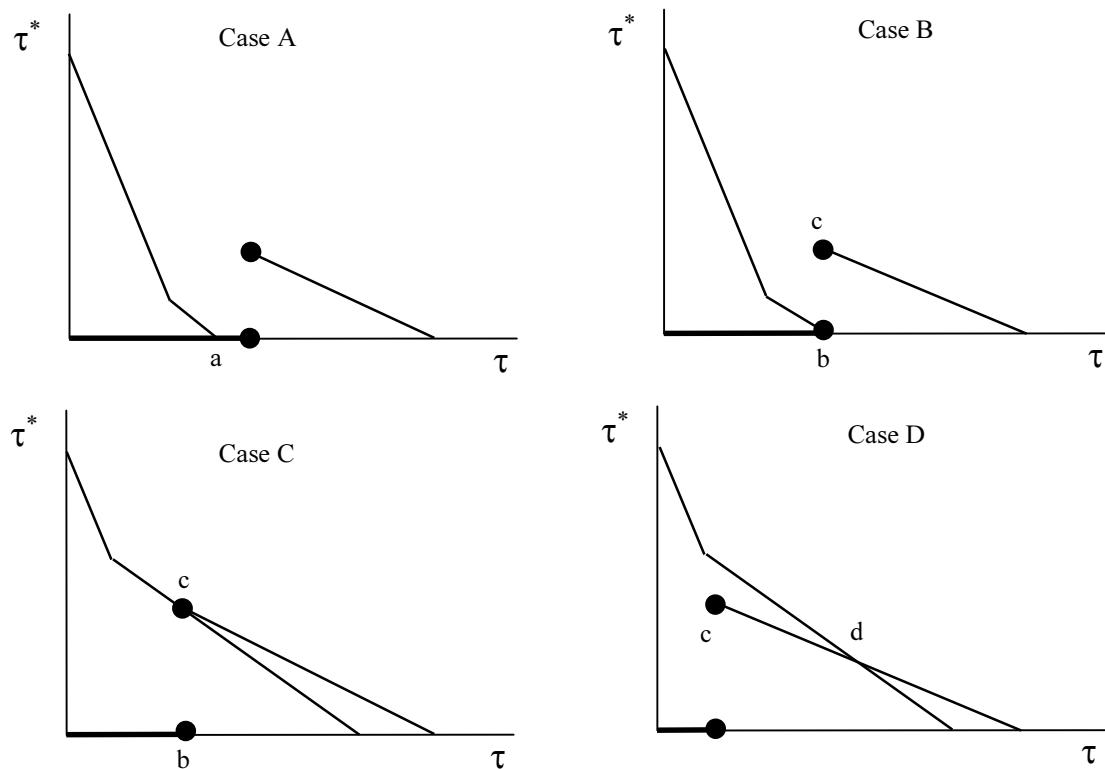
extra benefits from the tariff. This is a contradiction because developing welfare should improve.

Case C: Intersection at top break point

At point (c), we have full employment and the minimum wage barely binding, but from the derivation of the Developing reaction function, point (b) must give the same level of welfare to Developing as (c). That means that, if Developing drops its tariffs to zero, the minimum wage will still be binding and that Developing welfare will not change. This is a contradiction because Developing welfare should improve.

Case D: Intersection on Developing reaction curve

At point (d), we also have full employment and the minimum wage barely binding. Everywhere below the Industrial reaction function must indicate points of unemployment and the minimum wage binding. Therefore, for all points along the Developing reaction from point (d) to point (c), unemployment exists. However, the tariff levels between (d) and (c) describe points where Developing is setting a positive tariff that does not alleviate the minimum wage and only causes industrial distortions. This is a contradiction.

Having ruled out all these other pure strategy equilibria, only the equilibria described in the main text are possible.

C. Proof for proposition 5

In this section, we prove that a small increase in the minimum wage that moves the tariff equilibrium from the Johnson tariff-war case to the 'knife-edge' case can improve expected welfare of the industrial country. Because the analysis appeals to an envelope-theorem condition, we first show that all the variables under discussion are continuous and differentiable.

By assumption, the production and utility functions for both countries are twice continuously differentiable and are strictly monotonic in their arguments. The indirect utility functions, $V(\tau, \tau^*; \overline{w})$ and $V^*(\tau, \tau^*; \overline{w})$, are also twice continuously differentiable. The optimal tariff-reaction functions are found by maximizing indirect utility with respect to the own country tariff. For the industrial country, the maximization is

$$\tau\left(\tau^*, \overline{w}\right) = \max_{\tau} V\left(\tau, \tau^*; \overline{w}\right)$$

A similar maximization is carried out to find the developing country's tariff-reaction function. With a Jacobian matrix of first derivatives, which is

of full rank, we can apply the implicit function theorem to show that both tariff-reaction functions are at least once continuously differentiable.

The only other possible tariff equilibrium, aside from the original Johnson equilibrium and the degenerate case, must be the 'knife-edge' equilibrium described in the text. In this equilibrium, Developing chooses between two tariff levels, τ^*_h, which are taken from the old tariff-reaction function, and τ^*_0, which is always zero. Industrial's optimal tariff level, given that τ^*_h and τ^*_0 are played with probabilities ρ and $(1-\rho)$, will be τ_e. Expected welfare for the industrial country in this case is defined as follows:

$$EU = \rho(\overline{w})\ V(\tau, \tau^*_h; \overline{w}) + (1 - \rho(\overline{w}))\ V(\tau, \tau^*_0 ; \overline{w})$$

This entire equilibrium can be described by the following three equations:

(1) $\quad V^*\left(\tau_e, \tau^*_h; \overline{w}\right) = V^*\left(\tau_e, \tau^*_0; \overline{w}\right)$

(2) $\quad V^*_{\tau^*_h}\left(\tau_e, \tau^*_h; \overline{w}\right) = 0$

(3) $\quad \rho V_{\tau_e}\left(\tau_e, \tau^*_h; \overline{w}\right) + \left(1 - \rho\right) V_{\tau_e}\left(\tau_e, \tau^*_0; \overline{w}\right) = 0$

The first equation indicates that given $\overline{w}$, Developing's welfare if it plays either the high or low tariff is the same, while the second equation is Developing's first-order maximization condition and guarantees that the high tariff is on Developing's tariff-reaction function. Finally, equation (3) is Industrial's first-order maximization condition for expected utility, given ρ, and shows that τ_e satisfies the maximization.

Given ρ and $\overline{w}$, recursively, these three equations can be used to solve for the three critical tariff levels, τ^*_h, τ^*_0, and τ_e. The final step is then to implicitly solve for ρ in terms of $\overline{w}$. Using equation (3), we see that

$$\rho = \frac{V_{\tau_e}\left(\tau_e, \tau^*_0; \overline{w}\right)}{V_{\tau_e}\left(\tau_e, \tau^*_0; \overline{w}\right) - V_{\tau_e}\left(\tau_e, \tau^*_h; \overline{w}\right)}$$

Because all the functions on the right-hand side are at least once continuously differentiable in $\overline{w}$, ρ also must be. We can sign ρ by analysing each of the terms. The term $V_{\tau_e}\left(\tau_e, \tau^*_h; \overline{w}\right)$ is always negative because it represents the change in welfare if we increase the Industrial

tariff keeping the Developing tariff constant. Because we are to the right of the Industrial tariff-reaction function, such a movement must lead to a decline in welfare. By contrast, the numerator, $V_{\tau_e}\!\left(\tau_e,\tau_0^*;\overline{w}\right)$, is always positive. In this case, the zero Developing tariff indicates that the industrial country has unemployment. Any increase in the Industrial tariff then places upward pressure on the shadow wage and raises employment and welfare. Thus, ρ is a continuously differentiable function of $\overline{w}$ and is always positive and between zero and one.

If $V_{\tau_e}\!\left(\tau_e,\tau_h^*;\overline{w}\right)$ is zero, $\rho = 1$. This is a situation where the minimum wage is set at or below w_I and the developing country will play the high tariff with certainty. Conversely, if $V_{\tau_e}\!\left(\tau_e,\tau_0^*;\overline{w}\right)$ is zero, $\rho = 0$, and we are at the degenerate equilibrium when the minimum wage is at w_A.

The industrial country's expected utility is thus composed of terms that are all continuous and differentiable functions of $\overline{w}$, so we can safely take the derivative of expected welfare to find

$$d(EU)=\left\{\rho_{\overline{w}}V(\tau,\tau_h^*;\overline{w})+\rho\left[V_\tau\frac{d\tau}{d\overline{w}}+V_{\tau^*}\frac{d\tau_h^*}{d\overline{w}}\right]-\rho_{\overline{w}}V(\tau,\tau_0^*;\overline{w})+(1-\rho(\overline{w}))\left[V_\tau\frac{d\tau}{d\overline{w}}+V_{\tau^*}\frac{d\tau_0^*}{d\overline{w}}\right]+V_{\overline{w}}\right\}d\overline{w}$$

$$=\left\{\underline{\rho_{\overline{w}}\left[V(\tau,\tau_h^*;\overline{w})-V(\tau,\tau_0^*;\overline{w})\right]}+\underline{\underline{\rho V_{\tau^*}\frac{d\tau_h^*}{d\overline{w}}}}+\underline{\underline{\rho V_\tau\frac{d\tau}{d\overline{w}}+(1-\rho)V_\tau\frac{d\tau}{d\overline{w}}}}+\underline{\underline{\underline{V_{\overline{w}}}}}\right\}d\overline{w}$$

Note that $d\tau_0^*/dw = 0$ because the lower tariff is always zero. To sign this expression, we look at each term as follows:

- First term (underlined once)

  An increase in the minimum wage makes the developing country lower the probability of playing the high tariff ($\rho_w<0$). For a small increase in the minimum wage, this must be true because we move from the pure-strategy Nash equilibrium to the mixed strategy, which involves some degree of randomization. The bracketed part of the first term, on the other hand, is positive because welfare at the higher Developing tariff is greater than welfare when the developing tariff is zero. The reason for this is that, if Developing plays τ_0^*, the industrial country has unemployment. Therefore, the whole first term is negative.

- Second term (underlined twice)

  This term looks at the effect on Industrial welfare due to changes in the developing country tariff. Because τ^*_h will always be above the industrial country reaction function, V_{τ^*} is negative because we are once again in a situation of full employment. The second part, $d\tau^*_h/dw$, is also negative because the optimal developing country tariff, if Industrial increases the minimum wage, decreases, for example, the developing country reaction function is downward sloping. Thus, this term is always positive.

- Third term (underlined three times)

  This term is negative because $V_\tau < 0$ if τ is greater than the optimal tariff, but, by the envelope theorem, we know that the term is close to zero for small changes in the minimum wage.

- Fourth term (underlined four times)

This is the direct effect of the minimum wage on welfare without the tariff adjustment, for example, unemployment and a terms of trade loss. It is always negative.

Graphically, we can plot the main variables in terms of $\bar{w}$ (Figure 15). The symbol β, represents the point where we go from the old Johnson equilibrium to the 'knife-edge' case.

FIGURE 15
PLOTS OF CRITICAL VARIABLES

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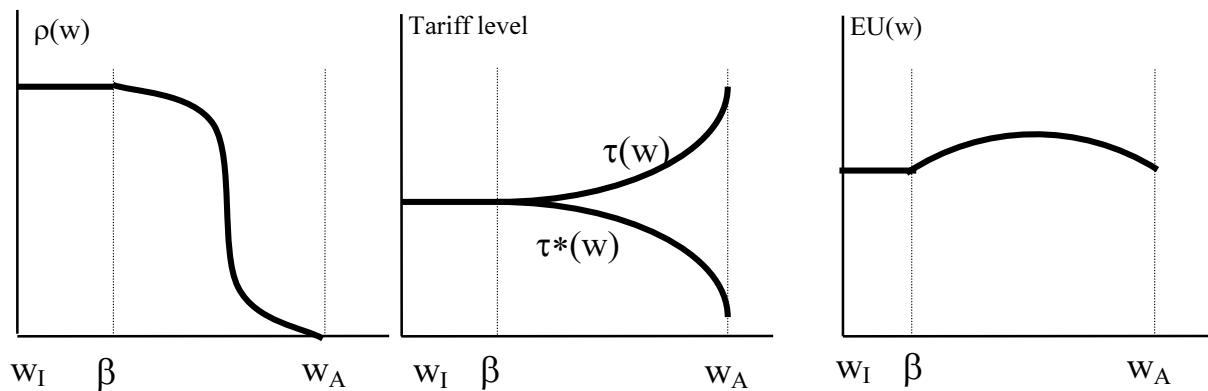
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