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Tariff Reforms with Rigid Wages

by

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Abstract

This paper analyses the effects of tariff reforms on welfare and market access in a competitive small open economy that is characterised by involuntary unemployment due to non-market clearing wages that are fixed either in terms of the numeraire or in real terms. We show that recent tariff-reform results can be extended to integrated reforms of tariffs and the wage rate, and that the inherent tension between reforms that increase welfare and market access carry over. We also derive welfare increasing tariff-reform strategies that keep the wage rate constant, and show that this tension may be attenuated.

JEL classification: F11, F13, F16

Keywords: Tariff Reform, Unemployment, Small Open Economy

Outline

1. *Introduction*
2. *The model*
3. *Integrated tariff and labour market reforms*
4. *Tariff reforms with a constant numeraire wage*
5. *Tariff reforms with a constant real wage*
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Non-Technical Summary

Import competing sectors in developed countries tend to be labour intensive and domestic job losses as a consequence of increased foreign competition in these sectors typically are of concern to policymakers in these countries. Most of the theoretical literature on piecemeal trade reform does not address this concern due to the assumption of competitive, perfectly adjusting labour markets. In this paper we consider trade liberalisation strategies in a framework that allows for the occurrence of these employment effects due to the presence of non-market clearing wages. We consider both a fixed "numeraire" wage and a fixed "real" wage (i.e. a wage that is fixed in terms of purchasing power and is adjusted for changes in the cost of living).

In doing this we draw on two recent developments in the piecemeal reform literature. The first is the addition of expanding market access to welfare-improvements as a target for policy reform. This is an important, policy-relevant extension, since improved access to export markets is the currency in which international negotiations over trade policy reform are bargained. The second development is the recent expansion of the range of reforms that can be shown to be welfare improving. This involved defining a generalised mean and variance for a tariff structure and then demonstrating that welfare is decreasing in this mean and variance. Thus reforms that reduce both the mean and the variance raise welfare. But when the same approach is applied to market access improving reforms, these are shown to decreasing in the mean but increasing in the variance, thus highlighting potential conflicts between these two objectives.

We begin by considering comprehensive reforms of trade and labour market policies and show that the recently developed tariff-reform formulae can readily be extended in this way. The welfare improving reforms are shown to involve reductions in both the real and numeraire wages, however. In contrast the set of market access improving reforms contain reforms that raise, reduce or maintain the real wage. We then turn to consider reforms of tariffs only, focussing on reforms that improve welfare. Given the presence of the wage constraint, some tariffs are (second-best) optimum, but we show that the existing formula can be modified and reinterpreted to cover the case where the numeraire wage is held constant. The conflict between market access and welfare improving reforms may be attenuated in these circumstances. We conclude by examining tariff reforms in the presence of a binding real wage. The interesting feature that this introduces is that tariff liberalisation now has an indirect effect on imports through the induced changes in the numeraire wage, in addition to its direct effect through product price changes. We indicate that the reform formula can also be extended to this case if appropriate modifications and reinterpretations in terms of "real" labour intensities are made.

1 Introduction

The analysis of piecemeal trade policy reform has evolved in – at least – three significant directions in recent years. First, Ju and Krishna (2000) supplement the traditional focus on welfare improvements as the objective of the reforms with considerations of market access. This is an important and policy-relevant extension, given that access to export markets, rather than welfare improvements per se, is the language in which negotiations over international trade policy reform are conducted. Their main result is that both market access and welfare cannot fall when tariffs are reduced, but that we cannot be sure that the standard welfare-improving reforms will also increase market access.

Second, Anderson and Neary (2007) significantly expand the range of reforms known to be welfare or market access improving. They formalise the notion that higher tariffs on average or a higher dispersion of tariffs for a given average are both likely to be welfare decreasing for a small country. They do this by defining a generalised mean and a generalised variance for a tariff structure and then demonstrate that the welfare effect of an arbitrarily small change in tariffs is fully described by its effects on these two moments of the tariff distribution. An increase in the generalised mean or generalised variance reduces welfare in general. Anderson and Neary then extend their investigation to market access and show that import value is generally declining in the generalised mean but increasing in the generalised variance of the tariff structure.

Finally, Kreickemeier (2005) introduces a binding minimum wage into the standard model of a competitive small open economy to consider the welfare effects of trade policy reform in the presence of involuntary unemployment. This distortion in the labour market gives trade policy a second-best welfare role, and implies that the labour-intensity of

import-competing industries will be crucial in designing programs of piecemeal trade policy reform. Tariff cuts reduce domestic producer prices and have employment effects whose sign depends on whether importables production is labour-intensive. This implies, for example, that the standard gains from a proportional tariff reduction will be supplemented by an additional welfare gain from increased aggregate employment as long as importables are not labour-intensive. But if importables are labour-intensive, which is the case that is arguably relevant for developed economies, then the adverse labour market effects could make a proportional tariff cut welfare reducing.

The present paper builds on all three contributions and derives new results for the welfare and market access effects of tariff reforms in the presence of rigid wages. It goes beyond the analysis of tariff reforms in Kreickemeier (2005) in three significant ways: First, it looks at the case of a rigid real wage in addition to the standard case of a minimum wage that is fixed in terms of the numeraire. While a rigid numeraire wage is a particularly transparent way to introduce a labour market distortion, a wage that is rigid in real terms – and therefore adjusts to changes in the cost of living due to changes in trade policy – is arguably more realistic.[1] Second, it uses the tools developed in Anderson and Neary (2007) to derive a larger set of welfare increasing reforms in the theoretically interesting case where the importables are labour intensive, and therefore trade liberalisation tends to lower domestic employment. Third, it looks at the effect of trade liberalisation on market access, thereby extending the work by Ju and Krishna (2000) and Anderson and Neary (2007) to the case of labour market imperfections.

[1]The quantitative difference between both types of rigidities is only significant if the protected sector is large, and therefore changes in trade policy have a sizable impact on the cost of living.

After setting up the model in Section 2, we consider integrated tariff and labour market reforms in Section 3. There, we show generalised radial reforms of goods market and labour market distortions that are welfare improving and market access increasing, respectively. We then focus on tariff reforms only, where the labour market distortion is a constant numeraire wage in Section 4 and a constant real wage in Section 5. Section 6 concludes.

2 The Model

Consider a competitive open economy, consuming and producing $n+1$ tradable goods. There is a single export good, labelled 0, which is traded freely with the rest of the world.[2] Its domestic output and price are denoted by y_0 and p_0, respectively. The export good serves as *numéraire*, i.e. $p_0 \equiv 1$ throughout. In addition, there are n import goods with outputs y and prices p. There are $m+1$ internationally immobile factors of production, where the vector v comprises m factors for which fully flexible factor prices ensure full employment of the exogenously given respective endowments.

There is an additional factor, labour, which is paid a minimum wage that may be fixed either in terms of the numeraire or in real terms and that is assumed to be binding throughout the analysis. Therefore, the employment of labour, L, is smaller than the economy's labour endowment $\bar{L}$. Numeraire wage w and real wage W are related via the price index P: $w = WP$, where $P \equiv \sum_j \sigma_j p_j$ and σ_j is the weight on the price of good j in the price index used to adjust the numeraire wage. These weights are taken as fixed throughout our analysis and reflect the (constant) expenditure shares that the

[2] Alternatively, the export good may be reinterpreted as a bundle of freely traded goods with constant relative world market prices.

wage setting institution applies in calculating the cost of living. In order to simplify the notation, we normalise the world market prices of all goods to one. Hence, the price index under free trade is equal to one as well, and $w = W$ under free trade. Using this result, the numeraire wage can be written as follows:

$$w = W(\sigma_0 + \sigma' p) = W(1 + \sigma' t) \tag{1}$$

Following Neary (1985), the production side of the economy is conveniently described by the restricted profit function:

$$g(p, w) \equiv \max_{y_0, y, L} \left\{ y_0 + p' y - wL \,|\, (y_0, y, L) \text{ feasible} \right\}, \tag{2}$$

where the price of the numeraire good and the endowments of the flexprice factors are suppressed as arguments of $g(\cdot)$ as they are held constant throughout the analysis.[3] It is assumed that $m > n$, i.e. that there are at least as many flexprice factors as traded goods in order to ensure the differentiability of $g(\cdot)$. From Hotelling's lemma, the partial derivatives of the restricted profit function are $g_p = y$ and $g_w = -L$. The allocation described by $g(\cdot)$ maximises the income of the fully employed factors, not the economy's value of production (GDP). The latter is given by

$$\text{GDP} = g(p, w) + wL(p, w) \equiv r(p, L(p, w)) \tag{3}$$

where $r(\cdot)$ is the standard revenue function (Neary 1985). The equivalence stated in (3) has a straightforward interpretation: The GDP in a minimum wage economy equals the GDP of an economy with full employment whose labour endowment is equal to the equilibrium labour demand in the minimum wage economy.

[3] All vectors are column vectors, their transposes are denoted by a prime.

The behaviour of the household sector is summarised by the standard expenditure function $e(p, u)$ with u representing aggregate welfare. As consumers derive utility only from the consumption of goods, all unemployment is involuntary. From Shephard's lemma, the price derivatives of the expenditure function are $e_p = x$, where x is the vector of Hicksian demand functions for the non-numeraire goods. The scalar e_u is the inverse of the marginal utility of income, and strictly positive.

Following Kreickemeier (2005), we define the minimum wage trade expenditure function

$$E(p, w, u) \equiv e(p, u) - g(p, w), \tag{4}$$

which gives the excess expenditure over the income of the flexprice factors. The derivative properties of $E(\cdot)$ follow from the standard properties of $e(\cdot)$ and $g(\cdot)$. In addition, $E(\cdot)$ is linearly homogeneous in (p_0, p, w). Equilibrium for the small open economy is given by

$$E(p, w, u) = wL + t'm \tag{5}$$

$$E_p(p, w, u) = m \tag{6}$$

$$E_w(p, w) = L \tag{7}$$

Totally differentiating (5), using (6) and (7) gives

$$E_u du = t'dm + wdL \tag{8}$$

Substituting for dm and dL leads to

$$\mu^{-1}du = \left[t'E_{pp} + wE_{wp}\right] dp + \left[t'E_{pw} + wE_{ww}\right] dw, \tag{9}$$

Here $\mu \equiv (E_u - t'E_{pu})^{-1}$ is the shadow price of foreign exchange. Following common practice it is assumed to be positive.[4] Hence, any policy reform which leads to the right

[4]See Neary (1995, p. 540) for a collection of arguments justifying this assumption.

hand side of (9) being positive is welfare increasing. Below, we look at three types of reforms: With integrated policy reforms, both dp and dw are independent policy variables. With a constant numeraire wage, only dp is a policy variable while $dw = 0$. Finally, with a constant real wage changes in the numeraire wage and the price vector are linked by $dw = W\sigma' dp$. In the latter case, the term in the second brackets is the effect of the induced change in the numeraire wage that is necessary to keep the real wage W constant. This adjustment links the labour market distortion directly to the product market distortions, a feature that we investigate more fully in section 5.

As is standard in the literature, we define market access M as the value of imports at world market prices, i.e. $M = p^{*\prime} m$. Totally differentiating and substituting for dm gives

$$dM = [(p^* + m_b t)' E_{pp} + m_b w E_{wp}]dp + [(p^* + m_b t)' E_{pw} + m_b w E_{ww}]dw, \qquad (10)$$

where $m_b \equiv (p^{*\prime} E_{pu})/(p^{*\prime} E_{pu} + E_{0u})$ is the marginal expenditure share of importables at world market prices, which is assumed to be strictly between zero and one. As in (9) for the welfare change, in (10) the first term in brackets gives the effect of a change in the price vector, while the second term in brackets gives the effect of a change in the numeraire wage. Again, depending on the type of comparative statics considered, dw may be an independent policy instrument, it may be equal to zero or it may be linked to the goods price change in order to keep the real wage constant.

3 Integrated Tariff and Labour Market Reforms

We focus on integrated policy reforms first. Let $\pi' \equiv (p', w)$ denote the price vector including the minimum wage, but excluding the numeraire. Assuming some substitutability

between the numeraire and non-numeraire goods is sufficient to ensure that the matrix $E_{\pi\pi}$ is negative definite.[5] The standard welfare equation can then be written as

$$\mu^{-1}du = (\pi - \pi^*)' E_{\pi\pi} d\pi, \tag{11}$$

where $\pi^{*\prime} \equiv (p^{*\prime}, 0)$ is the vector of shadow prices, taking into account that the shadow price of labour in the presence of minimum wage unemployment is zero (Kreickemeier, 2005). Hence, $(\pi - \pi^*)' = (t', w)$ is the vector of *shadow premia* (Neary 1995), defined as the difference between the market price of a good or factor and the respective shadow price. Dividing the shadow premia by the respective market prices gives the vector of *shadow premium rates* $T \equiv [D(\pi)]^{-1}(\pi - \pi^*)$, where $D(x)$ stands for a diagonal matrix with the elements of vector x on the main diagonal. The shadow premium rates for goods equal the *ad valorem* tariffs, defined in terms of domestic prices. Note that the shadow premium rate for labour, T_w, is equal to one, whereas $0 < T_j < 1$ for all importables. Hence, we have the following lemma from Kreickemeier (2005):

Lemma 1. *In a small open economy with a binding minimum wage, the shadow premium rate for labour is higher than any of the shadow premium rates on importables.*

We can now rewrite (11) as

$$(\mu \bar{s})^{-1} du = -T' \mathrm{S} dT \tag{11'}$$

where $\mathrm{S} \equiv -\bar{s}^{-1} D(\pi) E_{\pi\pi} D(\pi)$, with $\bar{s} \equiv -\pi' E_{\pi\pi} \pi > 0$, is a normalised substitution matrix. It is positive definite, with all elements summing to one. In contrast to the otherwise identical matrix in Anderson and Neary (2007), it is defined for a price vector that includes the wage rate.

[5] See Dixit and Norman (1980, p. 130).

We are now in a position to express the welfare effect of trade reforms in terms of generalised moments of the distortion vector, which in our case comprises not only all tariffs but also the wage rate. In analogy to Anderson and Neary (2007), we define the average shadow premium rate $\bar{T} \equiv \iota' \mathrm{S} T$ with ι denoting an $(n+1) \times 1$ vector of ones, and the generalised variance of shadow premium rates $V \equiv T' \mathrm{S} T - \bar{T}^2$. By construction, the weights in the determination of $\bar{T}$ sum to one. We assume in the following that $\bar{T}$ lies between the minimum shadow premium rate $T_{\min}$ and the maximum shadow premium rate $T_w = 1$.[6]

The changes of the generalised moments are defined as $d\bar{T} = \iota' \mathrm{S} dT$ and $dV = 2T' \mathrm{S}(dT - \iota d\bar{T})$, respectively.[7] Substitution into (11′) gives

$$(\mu \bar{s})^{-1} du = -\bar{T} d\bar{T} - \frac{1}{2} dV. \tag{12}$$

Hence, welfare increases with a decreasing average shadow premium rate and a decreasing variance of shadow premium rates.

The market access equation (10) can be written in terms of shadow prices and shadow premia as

$$\begin{aligned} dM &= \left[\pi^* + m_b(\pi - \pi^*)\right]' E_{\pi\pi} d\pi \\ &= \left[\pi - (1 - m_b)(\pi - \pi^*)\right]' E_{\pi\pi} d\pi, \end{aligned} \tag{13}$$

where in translating (10) into the first line of (13) we have used $p^{*\prime} dm = p^{*\prime} dm + 0 dL$.

[6] This is implied by the (clearly too strong) condition that all weights in the determination of $\bar{T}$ are positive, which will be the case if all importables are substitutes in net import demand for the numeraire, and furthermore the numeraire is labour intensive.

[7] As explained in Anderson and Neary (2007), the changes thus defined should be interpreted as Laspeyres-type approximations of the true changes (which would account for changes in S and π).

Eq. (13) is formally identical to the analogous expression in Anderson and Neary (2007), and hence it can be rewritten in terms of shadow premium rates as follows

$$\bar{s}^{-1}dM = -[\iota - (1 - m_b)T]'\mathrm{S}dT, \tag{14}$$

and in terms of average shadow premium rates and the variance of shadow premium rates as

$$\bar{s}^{-1}dM = -[1 - (1 - m_b)\bar{T}]d\bar{T} + \frac{(1 - m_b)dV}{2} \tag{15}$$

Hence, market access is increasing with a decreasing average shadow premium rate and an *increasing* variance in the shadow premium rates.

In Kreickemeier (2005), only two definitely welfare improving trade liberalisation strategies could be devised in the presence of a binding minimum wage:

(i) (*Radial Reduction*) Reducing all tariffs and the numeraire wage rate proportionally increases welfare.

(ii) (*Modified Concertina*) Reducing the highest tariff increases welfare if the good with the highest tariff is *not* labour intensive.

In this paper, we focus on trade liberalisation in the case where all importables are labour intensive, as this is the case about which not a lot could be said in Kreickemeier (2005).

We start by looking at welfare increasing reforms. In analogy to Anderson and Neary (2007), we can look at the generalised radial reform

$$dT = -[\gamma T + (1 - \gamma)\iota]d\alpha, \qquad 0 \leq \gamma \leq \frac{1}{1 - T_{\min}}, \qquad d\alpha > 0, \tag{16}$$

which can be written equivalently as

$$d\pi = D(\pi)dT = -[\gamma(\pi - \pi^*) + (1 - \gamma)\pi]d\alpha, \tag{16'}$$

given that $d\pi^* = 0$ due to the small country assumption. This reform is a weighted average between a reduction in prices in proportion to the associated shadow premia and a reduction in prices in proportion to their initial levels, where notably the weight on the first term can exceed one. For $\gamma = 0$, domestic goods prices and the numeraire wage are reduced in proportion to their initial levels. The higher γ, the greater the relative reduction in more distorted prices, where the size of the distortion is measured by the size of the respective shadow premium rate. Prices are reduced in proportion to the associated shadow premia for $\gamma = 1$. The extreme case $\gamma = 1/(1-T_{\min})$ is the super-concertina reform where all prices are lowered in proportion to the deviation of the associated shadow premia from the lowest one.[8]

The impact of reform (16) on the generalised tariff moments is given by

$$d\bar{T} = -(\gamma\bar{T} + 1 - \gamma)d\alpha \quad \text{and} \quad dV = -2\gamma V d\alpha, \tag{17}$$

and it is easily checked that both moments (weakly) decrease for $d\alpha > 0$ and γ in the given parameter range. Hence we have:

Proposition 1. *The generalised radial reform described in (16) increases welfare.*

We now check the implications of the generalised radial reform for the real wage. This effect can be inferred from the proportional change in the numeraire wage $\hat{w}$ and the proportional change in the price index $\hat{P}$, where $\hat{P} = \sum_{j=0}^{n} \beta_j \hat{p}_j$ and $\beta_j \equiv (\sigma_j p_j)/P$, with $\sum_{j=0}^{n} \beta_j = 1$. The change in the real wage implied by reform (16) can then be written as

$$\hat{w} - \hat{P} = -\left[1 - \sum_{j=1}^{n} \beta_j + \gamma\left(\sum_{j=1}^{n} \beta_j (1 - T_j)\right)\right] d\alpha. \tag{18}$$

[8] In this case, (16) becomes $dT = -(T - \iota T_{\min})d\alpha/(1 - T_{\min})$.

The term in brackets is always positive for γ in the given parameter range, and hence the generalised radial reform described by (16) reduces the real wage.

We now look at reforms that improve market access. To this end, consider the following reform:

$$dT = -[\delta(\iota - T) + (1 - \delta)\iota]d\alpha, \qquad 0 \leq \delta \leq 1, \qquad d\alpha > 0, \tag{19}$$

which – by multiplying the equation with $D(\pi)$ – can be written equivalently as

$$d\pi = -[\delta\pi^* + (1 - \delta)\pi]d\alpha. \tag{19'}$$

This reform is a weighted average between a reduction in prices in proportion to the associated shadow prices and a reduction in prices in proportion to their initial levels. For $\delta = 0$, domestic import prices and the numeraire wage are reduced in proportion to their initial levels. The higher δ, the smaller the relative reduction in more distorted prices. For $\delta = 1$ we get the anti-concertina reform, where all prices are reduced in proportion to their respective shadow prices. This implies that the wage stays constant, while *ad valorem* tariffs are reduced in proportion to their distance to the highest shadow premium rate $T_w = 1$. The impact of reform (19) on the generalised tariff moments is given by

$$d\bar{T} = -(1 - \delta\bar{T})d\alpha \quad \text{and} \quad dV = 2\delta V d\alpha, \tag{20}$$

and it is easily checked that the average tariff decreases and the variance (weakly) increases for $d\alpha > 0$ and δ in the given parameter range. Hence we have the following:

Proposition 2. *The generalised radial reform described in (19) increases market access.*

Note that the radial reforms (16) and (19) coincide for $\gamma = \delta = 0$. This observation implies, together with propositions 1 and 2:

Corollary 1. *A reduction of all prices in proportion to their initial levels increases welfare and market access.*

Intuitively, the proportional reduction in all prices leaves the variance of shadow premium rates constant (thereby neutralising the effect that has opposing effects on welfare and market access) while reducing their average (which is good for both targets).

The change in the real wage implied by the set of reforms (19) is given by

$$\hat{w} - \hat{P} = -\left[1 - \sum_{j=1}^{n} \beta_j - \delta\left(1 - \sum_{j=1}^{n} \beta_j T_j\right)\right] d\alpha. \tag{21}$$

It is immediate that the term in brackets is positive (and hence $\hat{w} - \hat{P} < 0$) for $\delta = 0$, while it is negative (and hence $\hat{w} - \hat{P} > 0$) with $\delta = 1$. This suggests that there is a market access increasing reform that leaves the real wage constant. It is straightforward to show that this reform is characterised by $\delta = 1 - \sigma_b$, where $\sigma_b = \sigma'\iota$ is the expenditure share of import goods in the price index.[9] This reform bears a resemblance to the so-called Ju-Krishna reform, which by Ju and Krishna (2000) has been shown to increase market access irrespective of any assumptions on substitutability between goods. As shown by Anderson and Neary (2007), the Ju-Krishna reform is a special case of (19), with $\delta = 1 - m_b$, and hence we know that the Ju-Krishna reform of tariffs and the minimum wage leaves the real wage constant if $\sigma_b = m_b$.

The reform possibilities are illustrated in figure 1 for the case where only a single importable is subject to a tariff. The pre-reform domestic price and wage are given by p_1^0 and w^0, respectively. The locus ww gives combinations of p_1 and w for which the minimum wage is just binding. It is implicitly defined by $E_w(p_1, w) = \bar{L}$, and hence its

[9] To show this, set the term in brackets in (21) equal to zero, and use the definition of β_j as well as the fact that (with world market prices normalised to one) we can write $t_j = p_j - 1$.

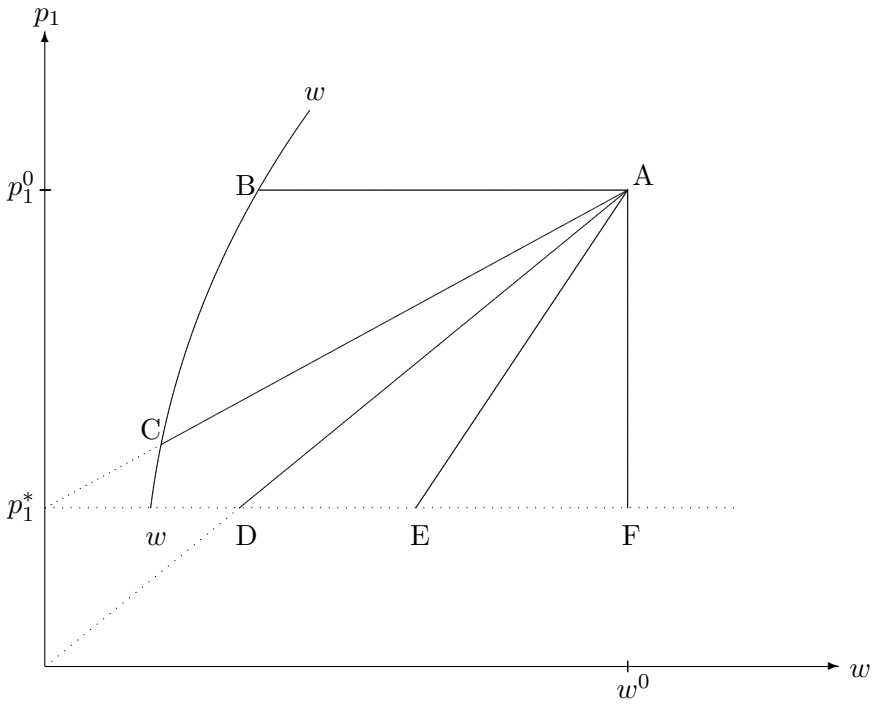

Figure 1: Integrated Tariff and Wage Reforms

slope is $dp_1/dw = -E_{ww}/E_{1w}$, which is strictly positive if good 1 is labour intensive. Reforms described in proposition 1 as welfare increasing are represented by movements in a (south-)west direction inside the cone spanned by AB and AD. The radial reduction of tariffs and the wage rate, shown by Kreickemeier (2005) to be welfare increasing, is represented by a movement along AC.

Reforms described in proposition 2 as market access increasing are represented by movements in a south(-west) direction inside the cone spanned by AD and AF. The anti-concertina reform is represented by a movement along AF, while the reform that leaves the real wage constant is represented by a movement along AE say. Hence we know that all reforms inside the sub-cone spanned by AE and AF increase market access as well as the real wage.

4 Tariff Reforms with a Constant Numeraire Wage

Now, consider reforms that are restricted to tariff changes. We start by deriving the constrained optimal tariff vector t_n^o, for a given level of the numeraire wage. Setting $dw = du = 0$ in (9) and solving for t gives

$$t_n^{o\prime} = -wE_{wp}\left(E_{pp}\right)^{-1} \tag{22}$$

and substituting back into (9) gives

$$\mu^{-1}du = t^{d\prime}E_{pp}dt, \tag{23}$$

with $t^d \equiv t - t_n^o$. In analogy to the previous section, we define a normalised substitution matrix $\widetilde{\mathrm{S}} \equiv -\tilde{s}^{-1}D(p)E_{pp}D(p)$, with $\tilde{s} \equiv -p'E_{pp}p > 0$, and the vector of deviations from the optimum ad valorem tariffs $T^d \equiv [D(p)]^{-1}t^d$. In general, the elements of T^d can be positive and negative. It turns out to be more convenient to work with the absolute value of the deviations, given by the vector $\tau \equiv D(\xi)T^d$, where ξ_j equals one (minus one) if T_j^d is non-negative (negative).[10] This allows us to rewrite (23) as

$$(\mu\tilde{s})^{-1}du = -\tau'\widetilde{\mathrm{S}}d\tau, \tag{23$'$}$$

Furthermore, the average absolute deviation from the optimum ad valorem tariff vector is given by $\bar{\tau} \equiv \iota'\widetilde{\mathrm{S}}\tau$, the variance of absolute deviations by $V_\tau \equiv \tau'\widetilde{\mathrm{S}}\tau - \bar{\tau}^2$, and their respective changes by $d\bar{\tau} = \iota'\widetilde{\mathrm{S}}d\tau$ and $dV_\tau = 2\tau'\widetilde{\mathrm{S}}(d\tau - \iota d\bar{\tau})$, again in direct analogy to the previous section. Substituting into (23$'$) gives

$$\left(\mu\tilde{s}\right)^{-1}du = -\bar{\tau}d\bar{\tau} - \frac{1}{2}dV_\tau. \tag{24}$$

[10] Note that $[D(\xi)]^{-1} = D(\xi)$.

Noting that (24) is formally identical to (12), with the average absolute deviation replacing the average shadow premium rate from the previous section, and the variance of absolute deviations replacing the variance of shadow premium rates, we know by analogy to proposition 1 that the reform

$$d\tau = -[\gamma\tau + (1-\gamma)\iota]d\alpha, \qquad 0 \leq \gamma \leq \frac{1}{1-\tau_{\min}}, \qquad d\alpha > 0 \tag{25}$$

increases welfare. The information on the sign of the required adjustment – with both positive and negative deviations from the optimum tariff vector – follows from $dT^d = D(\xi)d\tau$.[11]

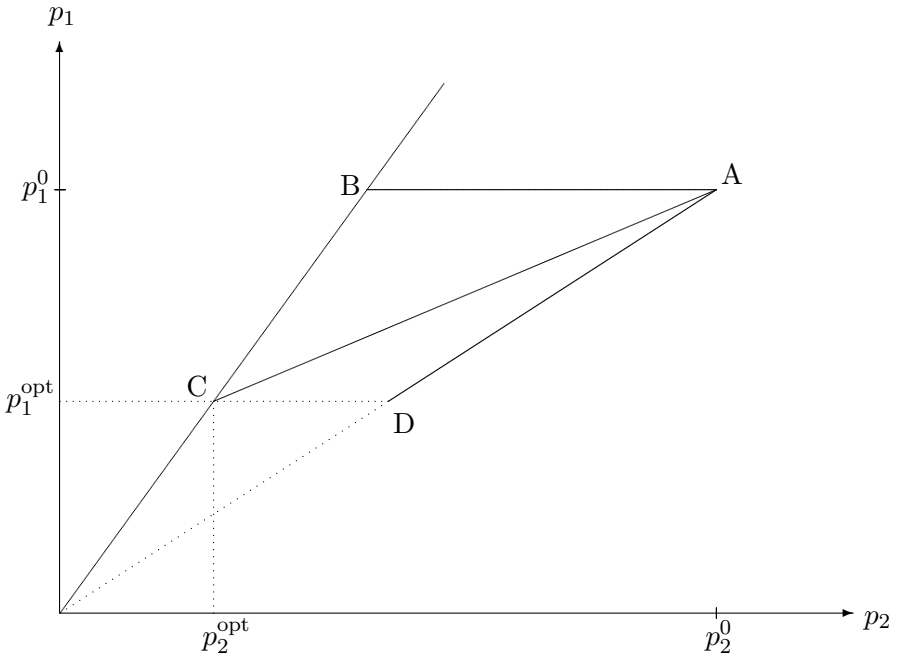

Figure 2: Restricted Tariff Reforms

[11] The adjustment in the price of good j follows as $dp_j = -[p_j - \gamma p_j^{\text{opt}}]d\alpha$ if $p_j - p_j^{\text{opt}} \geq 0$, while it equals $dp_j = [\gamma(p_j^{\text{opt}} - p_j) + (1-\gamma)p_j]d\alpha$ if $p_j - p_j^{\text{opt}} < 0$.

When $\gamma = 1$ this reform involves proportional adjustments towards the optimum tariffs and a reform of any size will raise welfare, until the optimum tariff vector is reached. The other reform paths involve indirect approaches to the optimum tariffs, which has the disadvantage of constraining the size of the reform at each step. These reforms can have the advantage of less demanding informational requirements, however. In this regard a particular role is played by the variant of reform (25) with $\gamma = 0$, as it does not require knowledge of the specific value of the optimum tariff vector. As long as all tariffs exceed the highest optimum tariff, lowering all domestic prices of importables in proportion to their initial values increases welfare.

The set of welfare increasing tariff reductions is illustrated in figure 2 for the case of two importables, where we have defined $p_j^{\text{opt}} \equiv 1 + t_j^o$, as the domestic price of good j implied by the optimum tariff. The analysis is analogous to figure 1, where now p^{opt} takes over the role of π^*.[12] The locus through points B and C denotes price combinations associated with equal deviations from the optimal tariff. Starting from A, a reform along AB (which targets only the largest deviation) should not be so large as to go beyond B, which would change the identity of the good with the largest deviation. Similarly, a reform along AD (where and both prices are reduced in proportion) should not be so large as to go beyond D, which would reverse the sign of one deviation. Hence, reforms identified as welfare increasing in (25) are represented by a movement in a (south-)west direction inside the cone spanned by AB and AD.

It is not as straightforward to derive a cone of market access increasing reforms in

[12] In the case we are looking at, where all importables are labour intensive, there is a presumption that – as drawn – the optimal tariffs are all positive. Kreickemeier (2005) shows that this outcome is assured if all importables are net substitutes for each other.

the case of a constant numeraire wage. It is possible to show, however, that the tension between welfare increasing and market access increasing reforms identified in Anderson and Neary (2007), which also holds in the integrated tariff and labour market reforms analysed in section 3 above, may be attenuated in the present context. To this end, we focus on the Ju-Krishna reform, which we know increases market access, and show that it can lie inside the cone of necessarily welfare increasing reforms.

In analogy to the earlier analysis the market access equation can be written as

$$\begin{aligned} dM &= p^{*\prime}(E_{pp}dp + E_{pu}du) \\ &= \left[m_b t^d + p^*\right]' E_{pp}dp, \end{aligned} \tag{26}$$

and therefore the Ju-Krishna reform is characterised by

$$dp = -\left(t - t^o + \frac{1}{m_b}p^*\right)d\alpha = -\left(p - p^{\text{opt}} + \frac{1}{m_b}p^*\right)d\alpha. \tag{27}$$

yielding minus a quadratic form in a negative definite matrix when substituted back into eq. (26). In contrast, focusing for simplicity on the case of positive deviations from the optimum tariff, the price change implied by welfare increasing reform (25) can be written as

$$dp = -\left(p - p^{\text{opt}} + (1-\gamma)p^{\text{opt}}\right)d\alpha \tag{28}$$

The Ju-Krishna reform lies in the cone of necessarily welfare increasing reforms if and only if the price changes implied by eqs. (27) and (28) coincide for an admissible value of γ.

Figure 3 illustrates the issue for the case of two importables. Vector $\overrightarrow{\text{AB}}$ equals $-(p - p^{\text{opt}})$, vector $\overrightarrow{\text{AC}}$ equals $-(1/m_b)p^* = -(1/m_b)\iota$, and vector $\overrightarrow{\text{AD}}$ equals $-p^{\text{opt}}$. The direction of price change required by the Ju-Krishna reform is found by adding $\overrightarrow{\text{AB}}$ and

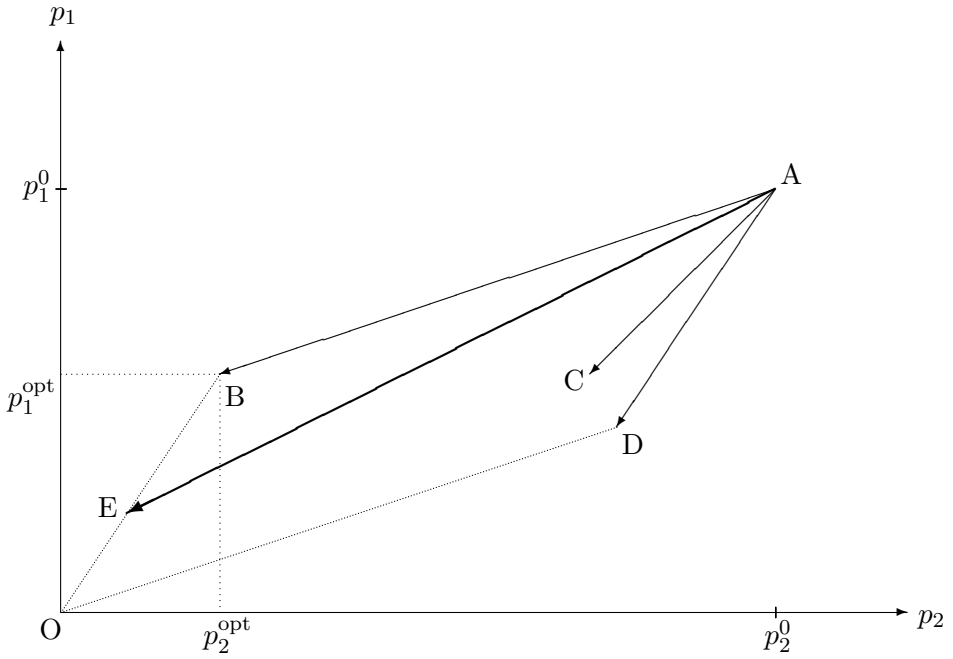

Figure 3: The Ju-Krishna Reform and Welfare

$\overrightarrow{\text{AC}}$, and the required *direction* is given by vector $\overrightarrow{\text{AE}}$, which equals $a(\overrightarrow{\text{AB}} + \overrightarrow{\text{AC}})$, $a > 0$, where the exact value chosen for a (and therefore the actual length of $\overrightarrow{\text{AE}}$) is not relevant. The set of welfare increasing reforms is given by $\overrightarrow{\text{AB}} + (1-\gamma)\overrightarrow{\text{AD}}$. The Ju-Krishna reform lies inside the cone of welfare increasing reforms if and only if a $\gamma \in [0, 1/(1-\tau_{\min})]$ can be found that makes $\overrightarrow{\text{AE}}$ and $\overrightarrow{\text{AB}} + (1-\gamma)\overrightarrow{\text{AD}}$ linearly dependent. It is easily verified by inspection of figure 3 that in the example given this is the case, as point E lies on OB.[13]

[13]Something more specific can be said in the case of many importables if all optimal tariffs are identical. Denote the common value of these optimal tariffs by the scalar t^o. Inspection of (27) and (28) shows that in this case the Ju-Krishna reform will lie in the set of welfare increasing reforms if $m_b > 1/(1+t^o)$.

5 Tariff Reforms with a Constant Real Wage

Trade liberalisation strategies in the presence of a constant real wage can be derived analogously to those for a constant numeraire wage, but the optimal tariff vector is different. Substituting $dw = W\sigma' dp$ in (9) and collecting terms leads to

$$\mu^{-1} du = \left[t' \widetilde{E}_{pp} + w \widetilde{E}_{wp} \right] dp \tag{29}$$

with

$$\widetilde{E}_{pp} \equiv E_{pp} + E_{pw} W \sigma'$$

$$\widetilde{E}_{wp} \equiv E_{wp} + E_{ww} W \sigma'$$

$\widetilde{E}_{pp}$ is an augmented substitution matrix that gives the changes in net imports following from a change in domestic prices, taking into account the implied changes in the numeraire wage needed to keep the real wage constant. Importable i is said to be an augmented net substitute for importable k if $\widetilde{E}_{p_k p_i} > 0$ (i.e. an increase in p_i increases imports of good k, taking into account the adjustment in the numeraire wage needed to hold the real wage constant). Importable i is an augmented net substitute for importable k if $E_{p_k p_i} < 0$.

$\widetilde{E}_{wp}$ is interpreted as a vector of general equilibrium *real* labour intensities: If and only if $\widetilde{E}_{wp_i} > 0$, i.e. if and only if an increase in p_i, combined with the induced increase in the numeraire wage to keep real wages constant, raises economy-wide employment, sector i is said to be labour intensive in real terms. Otherwise, sector i is said to be not labour intensive in real terms. This measure of labour intensity takes account of both the direct effect E_{wp_i}, whose sign is determined by i's labour-intensity in the standard sense (Kreickemeier 2005), and its indirect effect through the induced increase in the numeraire

wage ($E_{ww}W\sigma_i$), whose sign is always negative. Clearly the addition of a negative term tends to reduce the incidence of labour intensity.[14]

Going back to (29), the two terms in brackets are characterised as follows: The first term is a modified version of the standard volume of trade effect, giving the effect of a price change (including the induced wage change) on imports in distorted markets. The second term represents the welfare effects of employment changes induced by the change in prices. Substituting for w from (1) gives

$$\mu^{-1}du = \left[t'\widetilde{E}_{pp} + t'\sigma W\widetilde{E}_{wp} + W\widetilde{E}_{wp}\right]dp \tag{30}$$

The employment effect has now been separated into two components. The first of these ($t'\sigma W\widetilde{E}_{wp}$) is the indirect effect due to the tariff-induced premium in the nominal wage, while the second ($W\widetilde{E}_{wp}$) is the direct effect due to the rigid real wage itself.

In order to derive the optimum tariff vector we isolate the two effects attributable to the product market distortions and define

$$\mathrm{R} \equiv \widetilde{E}_{pp} + \sigma W\widetilde{E}_{wp} = \begin{pmatrix} I_n & \sigma W \end{pmatrix} \begin{pmatrix} E_{pp} & E_{pw} \\ E_{wp} & E_{ww} \end{pmatrix} \begin{pmatrix} I_n \\ W\sigma' \end{pmatrix}, \tag{31}$$

where I_n is the $n \times n$ identity matrix. R is a quadratic form in a negative definite matrix and hence is itself negative definite. From (30), the optimum tariff vector in the case of a constant real wage, t_r^o, is then given by:

$$t_r^{o\prime} = -W\widetilde{E}_{wp}\mathrm{R}^{-1} \tag{32}$$

[14] I.e., if a good is not labour-intensive in the standard sense, it is not labour-intensive in the real sense either, but a good can be labour intensive in the standard sense and not labour-intensive in the real sense. Since $p'\widetilde{E}_{pw} + \widetilde{E}_{0w} = 0$, not all goods can be labour intensive in the real sense.

While the elements of t_r^o cannot be signed in general, there is a result for an important special case:

Lemma 2. *Let all importables be augmented net substitutes for each other. Then, all second-best optimum tariffs are positive if all importables are labour intensive in the real sense.*

Proof. If all importables are augmented net substitutes for each other, all off-diagonal elements of $\widetilde{E}_{pp}$ are positive. If in addition all importables are labour intensive, $\sigma W \widetilde{E}_{wp}$ is a positive matrix, and hence the off-diagonal elements of $\mathrm{R} \equiv \widetilde{E}_{pp} + \sigma W \widetilde{E}_{wp}$ are positive as well, while the diagonal elements of R are negative, as the matrix is negative definite. Hence, R^{-1} is a negative matrix (Hatta 1977). With $\widetilde{E}_{wp} > 0$ the stated result follows. □

It is possible to at least locally compare the size of the optimal tariffs in the cases of fixed numeraire and fixed real wages, respectively. Specifically, we ask the question: Starting from the optimal tariff t_n^o, does a reduction in tariff levels increase or decrease welfare in the case of a fixed real wage? To this end substitute t_n^o into (9), and set $dw = W\sigma' dp$. Doing so gives

$$\mu^{-1} du = w(E_{ww} - E_{wp} E_{pp}^{-1} E_{pw}) W \sigma' dp,$$

where the term in brackets is a negative scalar.[15] Hence, lowering any tariff, starting from t_n^o increases welfare in the case of a fixed real wage. Hence, we can infer that t_r^o is strictly smaller than t_n^o.

[15] This follows from the observation that it is a main diagonal element of $E_{\pi\pi}^{-1}$, which – being the inverse of a negative definite matrix – is itself negative definite.

Substituting from (32) in (30), we get

$$\mu^{-1} du = (t - t_r^o)' \, \mathrm{R} dp \tag{33}$$

Eqs. (33) and (23) are of an identical form, with negative definite matrix R replacing E_{pp} and t_r^o replacing t_n^o. Hence, the analysis of section 4 can be applied analogously, and the results derived for the case of a fixed numeraire wage hold for the case of a fixed real wage as well.

6 Conclusion

Import competing sectors in developed countries tend to be labour intensive, and domestic job losses as a consequence of increased foreign competition in these sectors typically is a major concern to politicians in these countries. Most of the theoretical literature on piecemeal trade policy reforms does not allow to address this concern, however, due to the assumption of perfectly competitive labour markets that ensure full employment. In this paper, we derive welfare increasing trade liberalisation strategies in a framework that allows for the occurrence of these employment effects due to the assumption of non-market clearing wages that are fixed either in terms of the numeraire or in real terms. In doing so, we draw on Anderson and Neary (2007), who derive new welfare increasing reform strategies in a model without factor market distortions, and show how suitably modified variants of the tools developed in their paper – the generalised mean and variance of the distortions in the model – can be used to expand the set of welfare increasing liberalisation strategies known from the previous literature. We furthermore show that the principal tension between welfare increasing and market access increasing liberalisation strategies

remains valid in our framework with involuntary unemployment if we consider integrated reforms of all price distortions in the model.

Applying the modified Anderson and Neary formula for welfare-improving reforms leads to reductions in both the numeraire and real wages. But one particular market-access improving reform can be shown to hold the real wage constant, and furthermore to separate market access increasing reforms that reduce the real wage from those that raise it.

Recognising that the presence of a wage constraint implies (second-best) optimum tariffs, the Anderson and Neary formula for welfare improving reforms is shown to be readily extended to the case where the numeraire wage is held constant. It is shown furthermore that in this case the conflict between market access and welfare improving reforms may be attenuated. If tariffs are reformed in the presence of a binding real wage, liberalisation has an indirect effect on imports through induced changes in the numeraire wage in addition to its direct effects through the price changes themselves. The extended Anderson and Neary formula for welfare improving reforms is shown to apply in this case with appropriate modifications and reinterpretations in terms of real labour intensities.

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