Title	Domestic distortions and international trade
Authors(s)	Anderson, James E.; Neary, J. Peter
Publication date	1992-12-15
Series	UCD Centre for Economic Research Working Paper Series; WP92/17
Publisher	University College Dublin. School of Economics
Item record/more information	http://hdl.handle.net/10197/1688
Notes	A hard copy is available in UCD Library at GEN 330.08 IR/UNI

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DOMESTIC DISTORTIONS AND INTERNATIONAL TRADE

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WORKING PAPER NO WP92/17

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15 December 1992

* This paper was written with the support of a World Bank project on the cost of protection. For helpful comments, we are grateful to Geoff Bannister and to participants in seminars at the World Bank, the University of Konstanz and the EEA 92 Conference in Dublin.

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DOMESTIC DISTORTIONS AND INTERNATIONAL TRADE

ABSTRACT

In this paper, we develop techniques for measuring the trade policy equivalent of domestic distortions, using a distance function approach. Our measure, the Trade Restrictiveness Index, is shown to equal the uniform tariff which is welfare-equivalent to a given pattern of domestic taxes and subsidies. We extend the Index to incorporate taxes in non-traded goods and factor markets and illustrate its operationality with an application to liberalisation in Mexican agriculture. We conclude that our Index has considerable potential in empirical work and as an aid to trade negotiators.

JEL Classification: F13, F10

Keywords: Trade policy; Domestic distortions; Producer and consumer subsidy equivalents; Trade restrictiveness index.

DOMESTIC DISTORTIONS AND INTERNATIONAL TRADE

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DOMESTIC DISTORTIONS AND INTERNATIONAL TRADE

I Introduction

It is widely appreciated that government policies of a purely domestic nature can have major implications for a country's international trade. To give just one example, such implications have been widely discussed in the context of the current GATT round, in which US negotiators have insisted that intra-EC agricultural policy should be viewed as trade-distorting. However, analysts and negotiators have not hitherto had access to a conceptual framework which would allow the trade effects of domestic policies to be measured in a consistent way. In this paper, we propose such a framework and show how it may be implemented empirically.

Of course, other attempts have been made to quantify the overall distortionary effects of domestic policies. These have involved constructing empirically based indexes such as producer or consumer subsidy equivalents.[1] However, such measures have no theoretical foundation. Moroeover, since they use the shares of different sectors in production or consumption as weights, they are likely to be systematically biased: for example, sectors whose output levels are reduced by high taxation are assigned low weights whereas their "true" weights should be higher. By contrast, we show below that our approach is based firmly on welfare economics and correctly uses marginal rather than average production and consumption shares as weights.

The approach we propose draws on our recent work (Anderson and Neary, 1990, 1991) which dealt with trade distortions only. There we developed a scalar index equal to the equiproportionate rate of trade restriction which is equivalent (in welfare terms) to a given system of trade policies. For example, if trade is restricted by tariffs only, then our index equals the uniform tariff which is welfare-equivalent to the initial tariff structure.[2] We have shown that our index has a sound basis in standard welfare economics: it serves to synthesise

[1] See, for example, OECD (1991).

[2] For an early development of this approach, see Corden (1966).

the literature on "distance function" measures of welfare change[3] with that on the measurement of the cost of protection.[4] We have also argued that the index may be used in at least two alternative ways: either as an organising principle for reporting the results of computable general equilibrium models; or, with appropriate additional assumptions, as a technique for constructing approximate local measures of changes in policy restrictiveness in either partial or general equilibrium models.[5] In either case, the use of our index permits consistent comparisons of the restrictiveness of trade policy to be made across countries and across time.

All this previous work has considered only trade distortions, assuming that the domestic economy is undistorted. In the present paper, we show how this approach may be extended to incorporate purely domestic distortions. In effect, we ask what uniform tariff would be equivalent to a given set of domestic policy instruments. Measuring the trade impact of domestic policies in this way has obvious potential as an input into trade negotiations and as a summary of how a country's trade orientation has evolved. Of course, if the method is to be useful it is essential that it can be implemented empirically. We therefore devote considerable attention to showing that this can indeed be done and to illustrating some of the shortcuts which are necessary in empirical work.

The plan of the paper is as follows. Section II draws on Anderson and Neary (1991) to extend the theory of our measure, the Trade Restrictiveness Index (TRI),[6] to the case where domestic taxes or subsidies drive a wedge between the prices faced by producers and

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[3] See Debreu (1951), Deaton (1979) and Diewert (1985).

[4] Standard references include Foster and Sonnenschein (1970), Bertrand and Vanek (1971), Bruno (1972), Lloyd (1974) and Hatta (1977); the literature has been surveyed by Corden (1984) and Dixit (1987); and our index also takes account of recent extensions of the literature to incorporate the costs of quota as well as tariff protection by Corden and Falvey (1985), Falvey (1988), Neary (1988, 1989) and Anderson and Neary (1992).

[5] For partial equilibrium applications see Anderson (1991) and Anderson and Neary (1991); and for a general equilibrium application, see Anderson, Neary and Safadi (1992).

[6] In our first presentation of the measure, Anderson and Neary (1990), we called it the "coefficient of trade utilisation" reflecting its parallel with the "coefficient of resource utilisation" of Debreu (1951). That paper considered quota restrictions only whereas Anderson and Neary (1991) extended the measure to incorporate both tariffs and quotas. In the present paper we consider only price distortions but it is straightforward, if tedious, to incorporate quantitative restrictions by adapting the methods of our earlier papers.

consumers. The relationship between our index and the ad hoc producer and consumer subsidy equivalent indices in considered in Section III. Sections IV and V then examine how the Index can be adapted to allow for the effects of other types of domestic distortions, in markets for non-traded goods or factors of production. The results of a pilot application of the Index, which draws on a larger study of Mexican agriculture by Anderson and Bannister (1992), are presented in Section VI. Finally, Section VIII makes some concluding remarks.

II The Tariff Equivalents of Distortions in Traded Goods Markets

In this section, we introduce notation and assumptions and develop the theory of the Trade Restrictiveness Index (TRI) for the case where the only forms of policy intervention are taxes or subsidies to domestic producers or consumers in traded goods markets.

Throughout the paper we assume that the economy under consideration is small, trading with the rest of the world an untaxed numeraire good and n other goods whose given price vector is denoted p^*.[7] Because of domestic policies, this may differ from the price vector facing domestic producers, p, and from the price vector facing domestic consumers, q. Thus a particular traded good indexed by i may have a subsidy to production, so that $p_i - p_i^*$ is positive, or a tax, so that $p_i - p_i^*$ is negative. In addition, it may have a subsidy to consumption, so that $q_i - q_i^*$ is negative, or a tax, so that $q_i - q_i^*$ is positive. If the only form of intervention is trade policy, domestic producer and consumer prices are equal; thus, an import tariff (or export subsidy) is equivalent to an equiproportionate producer subsidy and consumer tax: $p_i = q_i > p_i^*$; and an import subsidy (or export tax) is equivalent to an equiproportionate producer tax and consumer subsidy: $p_i = q_i < p_i^*$. In the analysis which follows, it turns out to be most convenient to treat the producer and consumer prices themselves rather than the distortion wedges as the policy instruments. Since world prices are assumed fixed, these alternative procedures are of course equivalent.

The specification of the economy's behavioural equations uses standard dual techniques.[8] On the supply side, we assume until Section IV that production is carried out efficiently under competitive conditions. It may therefore be characterised by a GNP function, $g(p,v)$,

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[7] In Anderson and Neary (1991), we discuss how endogenous world prices can be incorporated.

[8] See Dixit and Norman (1980) for an overview.

which gives the maximum value of output that can be produced facing prices p, given the economy's factor endowments (denoted by the vector v) and technology. By Hotelling's Lemma, the price derivatives of this function, $g_p(p,v)$, give the economy's general equilibrium net supply functions, y(p,v). On the demand side, we abstract from distribution to concentrate on efficiency issues and assume that the economy can be represented by a single aggregate household. The behaviour of this household is characterised by an expenditure function, e(q,u), which gives the minimum expenditure needed to attain utility level u facing prices q. By Shephard's Lemma, the price derivatives of this function, $e_q(q,u)$, give the (compensated) consumer demand functions, x(q,u).

The existence of domestic policy distortions generates net government revenue, which may be positive or negative, equal to $(q-p^*)'x-(p-p^*)'y$.[9] Following standard convention, we assume that this is redistributed to (or, if negative, collected from) the private sector in a lump-sum fashion. The specification of equilibrium can now be completed by introducing a new function, the Balance of Trade Function, defined as the excess of consumer expenditure over income (the latter in turn equal to the sum of GNP and net government revenue):

$$(2.1) \qquad B(p,q,u) \equiv e(q,u) - g(p,v) - (q-p^*)'x(q,u) + (p-p^*)'y(p,v).$$

Note that the Balance of Trade Function is defined over the policy variables p and q; and that it is conditional on world prices p* as well as on all the other exogenous variables underlying the general equilibrium of the economy. Ignoring any exogenous international transfers, a full equilibrium of the economy can be characterised by the requirement that B(p,q,u) is zero.

While our main interest is in developing a measure of the tariff equivalent of an arbitrary set of distortions, it is helpful to digress and derive first the relationship between changes in distortions and changes in welfare. This is easily done by setting (2.1) equal to zero and totally differentiating, to obtain:

$$(2.2) \qquad B_u du = - B_p'dp - B_q'dq,$$

where:

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[9] All vectors are column vectors and a prime (') denotes a transpose.

$$(2.3) \quad B_u \equiv [1-(q-p^*)'x_I]e_u,$$

$$(2.4) \quad -B_p' \equiv -(p-p^*)'y_p,$$

$$(2.5) \quad -B_q' \equiv (q-p^*)'x_q.$$

The interpretation of (2.2) is relatively straightforward and familiar. The left-hand side gives the change in utility multiplied by a parameter B_u which may reasonably be assumed to be positive.[10] Utility therefore rises whenever the right-hand side is positive. To interpret this, recall that the matrix of price derivatives of supply, y_p, is positive semi-definite (since g is convex in p) and that the matrix of compensated price derivatives of demand, x_q, is negative semi-definite (since e is concave in q). It follows that if there is only a single distortion in either production or consumption, welfare will rise if its magnitude is progressively reduced; and if there are many distortions, welfare will rise if they are reduced in an equiproportionate manner (i.e., if $dp = (p-p^*)d\alpha$ or $dq = (q-p^*)d\beta$, where $d\alpha$ and $d\beta$ are negative scalars). More generally, any reduction of distortions is likely to raise welfare but, especially if it diverges significantly from proportionality, it need not do so.[11]

We are now ready to define the Trade Restrictiveness Index (TRI). Consider the discrete comparison between two equilibria, indexed by "0" and "1". Since international payments balance in both periods:

$$(2.6) \quad B(p^0,q^0,u^0) = B(p^1,q^1,u^1) = 0.$$

The TRI is now defined as the scalar factor of proportionality, or tariff factor surcharge,[12]

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[10] This term equals the marginal cost of utility multiplied by a "distortion multiplier" type of expression. If the term were not positive, the economy would be so distorted that a negative transfer would raise welfare, in which case the policy reform problem is trivial. Alternative sufficient conditions for the term to be positive are that equilibrium be stable under a utility-adjustment mechanism or that all goods be normal (the latter follows from the condition that $q'x_I$ equals $1-p_0x_{0I}$, where p_0 is the price of and x_{0I} is the income derivative of demand for the numeraire).

[11] Versions of the "concertina rule," first put forward by Bertrand and Vanek (1971), may also be developed for this model, to show that a reduction in the highest production or consumption distortion must raise welfare, provided the good in question is a net substitute for all other goods.

[12] We use the term "tariff factor" to refer to one plus the tariff rate; and we use the term "tariff factor surcharge" to refer to a tax on imports which multiplies the domestic *prices* of tariff-constrained goods by the tariff surcharge rate. This is not the same as raising *tariffs* by a uniform proportionate rate, except when the starting point is free trade.

by which period-1 prices would have to be adjusted to ensure balanced trade when utility is at its period-0 level. Formally, denoting the TRI by Δ:

$$(2.7) \quad \Delta(p^1,q^1,u^0) \equiv [\Delta : B(p^1/\Delta,q^1/\Delta,u^0) = 0].$$

To interpret this Index, we begin by considering two special cases. The first of these is where $p^1=q^1$ and $p^0=q^0$; in this case, tariffs are the only form of distortion and the Index measures the uniform tariff factor surcharge which is welfare-equivalent to the initial tariff structure: i.e., to compensate for a change in tariff policy from (p^0-p^*) to (p^1-p^*), it would be necessary to alter domestic prices by imposing a uniform tariff factor surcharge equal to the inverse of Δ.[13] The second special case is where $p^1=q^1=p^*$; in this case, the new equilibrium is undistorted (both producers and consumers face world prices) and to compensate for the move to free trade it would be necessary to impose a uniform tariff which raised prices by the inverse of Δ. Figure 1 illustrates this second case for a single good where $p^0 > p^* > q^0$, implying that both producers and consumers are subsidised in the initial equilibrium. The resulting welfare loss equals the sum of the producer surplus triangle ABC and the consumer surplus triangle DEF. By construction, the tariff factor $1/\Delta$ is welfare-equivalent to the policy vector (p^0,q^0) since it gives rise to an identical welfare loss, equal to the sum of the producer and consumer surplus triangles AGH and DIJ.[14]

Turning to the general case, in which the new equilibrium need not be undistorted $(p^1 \neq q^1 \neq p^*)$, the Index measures (one plus) the uniform tariff surcharge which is welfare-equivalent to the initial equilibrium. For a given initial equilibrium (p^0,q^0), Δ is greater the further the new equilibrium is from the undistorted equilibrium (in which $p^1=q^1=p^*$). Thus, for given (p^0,q^0), a rise in Δ corresponds to an increase in the trade restrictiveness of domestic taxes and subsidies.[15]

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[13] In this special case, the index is identical to the version considered in our earlier paper, Anderson and Neary (1991).

[14] Note that the tariff factor $1/\Delta$ gives rise to an import volume GJ which is lower than that in the free trade equilibrium, AD. By contrast, the same ranking need not hold for the import volume in the initial equilibrium, which equals BD plus EF. Of course, in general equilibrium, changes in the import volume in one market are balanced by opposing changes in import volumes in all other markets, so overall trade balance is maintained.

[15] This is why, in defining the TRI in (2.7), we adopt the convention of deflating p and q by Δ rather than scaling them up by Δ, which superficially might seem more attractive.

The level of the TRI is conceptually important. However, in many applications it is only practicable to estimate changes in the Index, so we must turn to interpret them. Totally differentiating (2.7) for a given reference level of utility, u^0, gives the effect on the Index of changes in the period-1 distortions:

$$(2.8) \qquad \Delta(B_p^{\prime}dp + B_q^{\prime}dq) - (B_p^{\prime}p + B_q^{\prime}q)d\Delta = 0.$$

Converting to proportional changes (writing $\hat{\Delta}$ for $d\Delta/\Delta$, etc.), this becomes:

$$(2.9) \qquad \hat{\Delta} = \frac{\sum_i (B_i p_i)\hat{p}_i + \sum_j (B_j q_j)\hat{q}_j}{B_p^{\prime}p + B_q^{\prime}q},$$

where B_i and B_j denote $\partial B/\partial p_i$ and $\partial B/\partial q_j$, respectively. From (2.2), the numerator of (2.9) equals (minus) the welfare effect of the distortion changes. This is normalised by the expression in the denominator: $B_p^{\prime}p + B_q^{\prime}q$. To interpret this, note that the derivatives of B with respect to the distorted prices may be interpreted as the "shadow quantities" associated with the distortions, and the denominator is the sum of these shadow quantities times the appropriate prices. Hence, the denominator may be interpreted as the "shadow value of distorted activity." Note, however, that it need not be positive: this depends on how close to proportionality are the distortions and on whether they drive home prices above or below world prices. Thus, the change in Δ need not have the same sign as the change in welfare: a movement towards a tax/subsidy regime which is equivalent to a greater degree of trade restrictiveness may be associated with either a rise or a fall in welfare. Finally, note that all the terms needed to calculate $\hat{\Delta}$ are estimable. Our approach therefore provides the basis of an operational method of measuring the restrictiveness of producer and consumer distortions which (because of the appropriate normalisation) permits consistent comparisons across countries and across time.

III Ad Hoc versus True Producer and Consumer Subsidy Equivalents

Inspecting equations (2.7) and (2.9) in the previous section, it is clear that the TRI (in both level and rate of change form) has two distinct components, corresponding to changes in producer and consumer taxes and subsidies respectively. In this section we spell out this decomposition, which is of interest in itself and also allows a comparison of our approach with the commonly used ad hoc measures of producer and consumer subsidy equivalents.

Returning to (2.7), consider the outcome of defining a distortion index separately for production and consumption distortions, rather than for both together. For production distortions, this leads to a *true producer subsidy equivalent index*, Δ^p, defined as:

$$(3.1) \qquad \Delta^p(p^1,q^1,u^0) \equiv [\Delta^p : B(p^1/\Delta^p,q^1,u^0) = 0].$$

Here, Δ^p gives the equiproportionate change in production distortions alone which is welfare-equivalent to the policy change from period 0 to period 1. The rate of change of this index is analogous to that of the full index Δ and is calculated in the same manner:

$$(3.2) \qquad \hat{\Delta}^p = \frac{\sum_i (B_i p_i)\hat{p}_i}{B_p' p}.$$

This may be compared with the change in the ad hoc producer subsidy equivalent index:

$$(3.3) \qquad P\hat{S}E = \frac{\sum_i (y_i p_i)\hat{p}_i}{y' p}.$$

Comparing (3.2) and (3.3), and recalling the definition of the B_i parameters in (2.4), it is clear that the difference between the two indices hinges on the use of average production shares as weights in (3.3) as opposed to marginal production shares in (3.2).[16]

An identical series of derivations can be carried out for consumption distortions. Firstly, we can define a *true consumer subsidy equivalent index*:

$$(3.4) \qquad \Delta^q(p^1,q^1,u^0) \equiv [\Delta^q : B(p^1,q^1/\Delta^q,u^0) = 0].$$

Once again, the proportionate change in this index is a weighted average of the distortion changes, where the weights are marginal consumption shares:

[16] The numerator of the average weights is just quantity times price, whereas that of the marginal weights equals, from (2.5), the sum of each distortion times the rate of change of each distorted activity, times the price. This switch from a linear to a quadratic structure is exploited by Anderson (1992) to show that the TRI can be decomposed into two terms, one a function of the average tariff and the other a function of the generalised variance of tariffs.

$$(3.5) \qquad \hat{\Delta}^q = \frac{\sum_j (B_j q_j)\hat{q}_j}{B_q' q} .$$

This should be compared to the change in the ad hoc consumer subsidy equivalent:

$$(3.6) \qquad C\hat{S}E = \frac{\sum_j (x_j q_j)\hat{q}_j}{x' q} ,$$

where average consumption shares are inappropriately used as weights.

Bringing together these results, the change in the full Trade Restrictiveness Index can be expressed as a weighted average of the changes in the true producer and consumer subsidy equivalent indices:[17]

$$(3.7) \qquad \hat{\Delta} = \lambda \hat{\Delta}^p + (1-\lambda)\hat{\Delta}^q ,$$

where the weights reflect the contributions of production and consumption distortions to the total shadow value of distorted activity:

$$(3.8) \qquad \lambda \equiv \frac{B_p' p}{B_p' p + B_q' q} .$$

This serves to place in perspective the advantages of our approach over the commonly used alternative: it uses appropriate weights and it also correctly aggregates the effects of changes in the two types of distortions.

Finally, our approach permits an alternative decomposition of the change in trade restrictiveness: by commodity rather than by type of instrument. For some purposes it may be of interest to establish which commodities have contributed most to the overall change in trade restrictiveness. By analogy with (3.7), an appropriate method of doing this is to decompose the change in Δ as follows:

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[17] This result is an approximation only, since the changes in the three indices, Δ, Δ^p and Δ^q, are evaluated at different points, as a comparison of the arguments in equations (2.7), (3.1) and (3.4) shows.

$$(3.9) \qquad \hat{\Delta} = \sum_j \mu_j \hat{\Delta}_j ,$$

where $\hat{\Delta}_j$ is the change in the distortion index for commodity j, defined as:

$$(3.10) \qquad \hat{\Delta}_j = \lambda_j \hat{p}_j + (1-\lambda_j)\hat{q}_j .$$

Here the μ_j and λ_j parameters are weights, giving respectively the contribution of distortions in the market for good j to the total shadow value of distorted activity and the contribution of production distortions to the shadow value of distorted activity in good j:

$$(3.11) \qquad \mu_j \equiv \frac{(\partial B/\partial p_j)p_j + (\partial B/\partial q_j)q_j}{B_p' p + B_q' q} ,$$

$$(3.12) \qquad \lambda_j \equiv \frac{(\partial B/\partial p_j)p_j}{(\partial B/\partial p_j)p_j + (\partial B/\partial q_j)q_j} .$$

IV Distortions in Non-Traded Goods Markets

It is relatively straightforward to incorporate distortions in non-traded goods markets into the framework used so far. Let c and h denote respectively the producer and consumer prices of non-traded goods. Adding them to the list of arguments of the expenditure and GNP functions, the condition for equilibrium in non-traded goods markets may be written as:

$$(4.1) \qquad e_h(q,h,u) = g_c(p,c,v).$$

This may now be solved for the equilibrium producer price vector, c, which depends on all the exogenous variables including the vector of distortions in the non-traded goods markets themselves, $h-c$, which we write as τ:

$$(4.2) \qquad c = c(\tau,q,p,u,v).$$

The derivatives of this function are easily derived from (4.1); for example, the effect of changes in distortion levels τ on the producer prices c equals:

$$(4.3) \qquad c_\tau = (g_{cc}-e_{hh})^{-1}e_{hh}.$$

Incorporating this endogenous determination of c (and hence, for given τ, of h), the amended Balance of Trade Function becomes, instead of (2.1):

$$(4.4)\qquad B(p,q,\tau,u) \equiv e\{q,h(.),u\} - g\{p,c(.),v\} - (q-p^*)'x\{q,h(.),u\} + (p-p^*)'y\{p,c(.),v\} - t'e_q\{q,h(.),u\}.$$

Consumer demands x now depend on the producer prices of traded goods p indirectly through their dependence on non-traded goods prices h; and similarly supplies depend indirectly on consumer prices q.

The Trade Restrictiveness Index may now be extended to the case where some goods are non-traded. Equation (2.7) becomes:

$$(4.5)\qquad \Delta(p^1,q^1,\tau^1,u^0) \equiv [\Delta : B(p^1/\Delta,q^1/\Delta,\tau^1,u^0) = 0].$$

Note that the index is defined by deflating p and q but not τ. This reflects the fact that it is an index of *trade* restrictiveness: it equals the uniform scaling factor applied to tariffs alone which would compensate for the changes in distortions in *both* traded and non-traded sectors. Differentiating (2.7) to obtain the change in the index yields, instead of (2.9):

$$(4.6)\qquad \hat{\Delta} = \frac{\sum_i (B_i p_i)\hat{p}_i + \sum_j (B_j q_j)\hat{q}_j}{B_p' p + B_q' q} + \frac{B_\tau' d\tau}{\Delta(B_p' p + B_q' q)} .$$

The first term on the right-hand side, relating $\hat{\Delta}$ to distortion changes in traded goods markets, is identical to that in (2.9), except that the derivatives of B must now take account of induced changes in the prices of non-traded goods. The second term, which incorporates the effects of distortion changes in non-traded good markets, is also estimable in principle, although a new feature introduced is that the *level* of Δ now appears in the denominator. This raises some additional issues in empirical applications, but they do not significantly reduce the applicability of the method.[18]

V Distortions in Factor Markets

So far, we have assumed that the only forms of distortions are in final goods markets and that production is carried out efficiently within and between sectors. However, a significant number of distortions occur in factor markets rather than in goods markets and it is desirable to have a method of quantifying their trade equivalents also. To do this we must go behind the economy-wide production structure given by the GNP function and allow for inefficiencies arising from differences in factor prices between sectors.[19]

To illustrate how this may be done, suppose that the economy can be divided into two sectors, labelled "1" and "2", such that factors are allocated efficiently within but not between the two sectors. Each of these "sectors" may itself be made up of a number of distinct sub-sectors. We assume that the only form of goods-market distortions are tariffs (so that q equals p) and that import-competing goods are produced in sector 1 only. (These assumptions are made solely to simplify the exposition; the Appendix shows how they may be relaxed.) The assumption that factors are allocated efficiently within sectors 1 and 2 allows us to specify sectoral product functions $g^1(p,v^1)$ and $g^2(v^2)$ for each. The allocations

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[18] This problem may be overcome by multiplying (4.6) by Δ and treating it as a first-order linear differential equation in Δ:

$$(4.7) \qquad \frac{d\Delta}{dt} = a\Delta + b,$$

where a and b are the two right-hand side coefficients of (4.6). The solution for Δ is:

$$(4.8) \qquad \Delta(t) = \left[\Delta(t-1) + \frac{b}{a}\right] e^{at} - \frac{b}{a}.$$

In practical applications, where we must work with discrete data, we start with the difference equation analogous to (4.7) and solve to obtain:

$$(4.9) \qquad \Delta(t) = [(1+a)\Delta(t-1) + b].$$

This may be applied to each interval of change (each with different values of a and b), along with the normalisation condition that Δ be equal to one in the initial period.

[19] A substantial literature developed in the 1970s dealing with factor-market distortions, although it paid relatively little attention to their implications for international trade itself; see for example, Jones (1971), Magee (1973) and Neary (1978). Our approach here is closest to Dixit and Norman (1980), Section 6.3, and to Jones and Neary (1991).

of factors to sectors, represented by the vectors v^1 and v^2, are not given but adjust endogenously to meet the full-employment constraint:

$$(5.1) \qquad v^1 + v^2 = v,$$

and the factor-price constraint. A general way of specifying the latter, following Jones and Neary (1991), is to write the factor price vector in sector 1, denoted by w^1, as a function of the factor price vector in sector 2, denoted by w^2, and of a vector of distortion parameters, denoted by γ:

$$(5.2) \qquad w^1 = f(w^2,\gamma).$$

This specification encompasses as special cases many important special forms of factor-market distortion. To see this, differentiate (5.2) totally:

$$(5.3) \qquad dw^1 = f_w dw^2 + f_\gamma d\gamma.$$

Different types of factor-market distortion may now be expressed in terms of restrictions on the elements of the two square matrices, f_w and f_γ. For example, absolute differentials imply that f_w and f_γ both equal the identity matrix, I; proportional differentials ($w^1 = \Gamma w^2$ where Γ is the diagonal matrix formed from the vector γ) imply that f_w equals Γ and f_γ equals W, the diagonal matrix formed from the vector w^2; and sector-specific factor-price rigidities can be represented by setting all the elements in the corresponding rows of f_w equal to zero. The production side of the model is completed by the assumption that factors are allocated efficiently within sectors, i.e., that factor prices are equal to sectoral value marginal products:

$$(5.4) \qquad w^1 = g^1_v(p,v^1) \qquad \text{and} \qquad w^2 = g^2_v(v^2).$$

The economy's total product is then the sum of outputs from the two sectors:

$$(5.5) \qquad g(p,v,\gamma) = g^1\{p,v^1(.)\} + g^2\{v^2(.)\},$$

where v^1 and v^2 are determined endogenously by (5.1), (5.2) and (5.4). (The derivatives of (5.5) are given in the Appendix.)

The remaining steps in deriving the Trade Restrictiveness Index in the presence of factor-market distortions are familiar. The Balance of Trade Function for this model becomes:

$$(5.6) \qquad B(p,\gamma,u) \equiv e(p,u) - g(p,v,\gamma) - (p-p^*)'[e_p(p,u) - g^1_p\{p,v^1(.)\}].$$

We are now able to define the Trade Restrictiveness Index for this model. Just as in Section II, it equals the proportional tariff surcharge factor which would compensate for the changes in both tariffs and factor-market distortions between periods 0 and 1:

$$(5.7) \qquad \Delta(p^1,\gamma^1,u^0) \equiv [\Delta : B(p^1/\Delta,\gamma^1,u^0) = 0].$$

In proportional change form, this becomes:

$$(5.8) \qquad \hat{\Delta} = \frac{\sum_i (B_i p_i)\hat{p}_i}{B_p' p} + \frac{B_\gamma' d\gamma}{\Delta B_p' p}.$$

This is similar to equation (4.6) and, like it, poses no new problems of estimation in principle.

VI An Application: The Tariff Equivalents of Mexican Agricultural Policy

To illustrate the application of the Trade Restrictiveness Index, we turn next to a case study of an important phase in the liberalisation of the Mexican economy: the reforms of agricultural policy in the late 1980's. Drawing on a more complete study (Anderson and Bannister, 1991), we calculate the change in the Trade Restrictiveness Index for ten crops, taking account also of subsidies to fertiliser use, over the five years 1985 to 1989.

As in most countries, the pattern of government intervention in Mexican agriculture is extremely complicated: most commodities are subsidised at both the consumer and producer levels and also benefit from input subsidies, especially to fertiliser use. Additional subsidies apply in the market for the single most important crop, maize (which accounts for over half of Mexican agricultural production and about a quarter of its agricultural imports). In particular, whole maize (which is a traded good) is the principal input into milled maize, which is a non-traded good and benefits from a subsidy. Table 1 shows the extent of the changes, over the period we consider, in the rates of subsidy to maize and to fertiliser usage. The pattern of policy change revealed is a complicated one, with no clear inferences possible without the construction of some overall index number of policy restrictiveness. The standard producer and consumer subsidy equivalent indices can be constructed for this model and the picture they reveal is discussed below. However, their theoretical shortcomings have already been outlined in Section III. So it is desirable to apply the new measure we have introduced above.

For the particular application considered here, the version of the equation defining changes in Δ which we need to estimate is:

$$(6.1) \qquad \hat{\Delta} = \frac{\sum_i (B_i p_i)\hat{p}_i + \sum_j (B_j q_j)\hat{q}_j + B_f df + (1/\Delta)B_\tau d\tau}{B_p' p + B_q' q + B_f f} .$$

where p and q denote producer and consumer prices of traded goods as before, f denotes the domestic price of the traded input, fertiliser, and τ denotes the subsidy to milled maize usage. To operationalise this equation, we require estimates of the supply and demand responses which underlie the derivatives of the balance of trade function, as given in equations (2.4) and (2.5). Ideally, these should come from a computable general equilibrium model, but, as is typically the case in applied work, such a model, with a commodity disaggregation compatible with the set of policy instruments in which we are interested, has not been estimated for the Mexican agricultural sector. We must therefore have recourse to partial equilibrium estimates. For the present study, we assume that all cross-price elasticities are zero and take estimates of own-price elasticities of output supply and input demand from a study by Nathan and Associates.

The results of using these elasticity estimates in equation (6.1) are given in the first row of Table 2.[20] The pattern of changes in trade restrictiveness revealed by the overall TRI is clearcut. The TRI shows a large increase in restrictiveness in 1986 and especially 1987 followed by major reductions in restrictiveness in 1988 and 1989. The cumulative effect of these changes is a 40.9% fall in trade restrictiveness over the four-year period.

As we noted at the end of Section III, it is possible to decompose the overall change in the TRI in order to pinpoint the sources of change. Firstly, we consider the decomposition by type of agricultural commodity. The next eleven rows of the Table show that the dominant influence on the overall index has been policy towards maize. However, it has not always been decisive: in 1986, for example, a significant tightening of policy in the sorghum market dominates a mild liberalisation in maize policy to yield an overall rise in restrictiveness.

[20] Anderson and Bannister (1991) show that the results are not unduly sensitive to changes in the elasticity estimates used.

The next three rows in Table 2 present an alternative decomposition of the overall change in the TRI: this time, by type of instrument rather than by commodity group. Referring to equation (3.7), the first of these rows gives the calculated values of $\lambda\hat{\Delta}^{p}$, and analogously for the remaining two rows. This reveals that by far the bulk of the change in the index is accounted for by changes in production subsidies. Changes in consumption and fertiliser subsidies, by contrast, account for extremely small changes in the overall stance of policy.

Finally, it is of interest to compare the pattern of policy change revealed by the TRI with that suggested by the ad hoc producer and consumer subsidy equivalent indices. This is done in the final four rows of Table 2. The decomposition of changes in overall restrictiveness revealed by the "true" indices, Δ^{p} and Δ^{q}, is similar to that revealed by the earlier decomposition by policy instrument. By contrast, the pattern of changes in the ad hoc PSE and CSE indices is completely different. Comparing first the PSE with Δ^{p}, the movements in the two are in the same direction in only three of the four years and in those three years the magnitude of the change in Δ^{p} ranges from five to fourteen times that in the PSE. While the cumulative changes in the two indices are comparable, it is clear that the PSE is a totally inadequate guide to changes in the true index Δ^{p}. Similar discrepancies between changes in the CSE and in the true consumer subsidy index Δ^{q} show that here too the ad hoc measure cannot be relied upon to provide an accurate reflection of the change in the restrictiveness of consumer price policies. Recalling that there is no consistent method of aggregating the PSE and CSE suggests that, despite the limitations of the TRI enforced by the need to use crude elasticity estimates, there is no alternative to using it if we seek an index of the overall impact on trade of policy in domestic markets.

VII Conclusions and Suggestions for Further Research

In this paper, we have proposed a new approach to evaluating the implications for international trade of domestic tax and subsidy policies. The measure meets a clear need, since the importance of domestic policies is increasingly recognised in trade negotiations and since consistent measures of the degree to which different countries have adopted trade-favouring policies are needed to test many of the hypotheses of the new literature on trade and growth. Moreover, the measures which have been used hitherto for these purposes have been shown to lack any theoretical foundation and to be unamenable to consistent aggregation. By contrast, the measure we have proposed in this paper has a secure foundation in standard welfare economics and permits consistent aggregation over different policy instruments and over different commodity groups.

Turning to applications, we showed how our approach can be applied by considering a case study of changes in the trade restrictiveness of Mexican agricultural policy from 1985 to 1989. The pattern of change during four years of important policy changes which our results reveal is of considerable interest in itself. More generally, the application presented in Section VI (and considered in much more detail by Anderson and Bannister (1991)), shows that the TRI incorporating changes in domestic policies can be successfully estimated using only the sort of existing parameter estimates (mainly own-price elasticities) which are available for many markets.

There are clearly many directions in which it would be desirable to extend the analysis of this paper. At the empirical level, it would be desirable to investigate the robustness of the estimates of trade restrictiveness to more satisfactory and comprehensive sets of parameter estimates. It would also be desirable to incorporate explicitly the effects of distortions in factor markets along the lines indicated in Section V. Finally, consistent estimates of the TRI for different countries should be calculated to illustrate the pattern of international differences in trade liberalisation and to explore the effects of such liberalisation on economic performance. As for the theoretical level, much remains to be done to extend the conceptual framework to incorporate distributional and intertemporal considerations, and to allow for more general specifications of the production sector. We believe that this research agenda promises to extend considerably our knowledge and understanding of the processes and effects of trade liberalisation.

APPENDIX

In this Appendix, we provide further details on the behaviour of the economy in the presence of factor-market distortions. Sections A.1 and A.2 show how to calculate the price and distortion derivatives of the GNP function and the output supply functions respectively. These are a necessary step in calculating the derivatives of the Balance of Trade function (5.6), which are needed in order to evaluate the expression for $\hat{\Delta}$ in (5.8). Section A.3 then shows how the approach to modelling factor-market distortions adopted in Section V can be generalised to allow for any number of sectors, all of which may produce the import-competing goods.

A.1 Derivatives of the GNP Function: $g(p,v,\gamma)$

The GNP function was defined in (5.5). Totally differentiating this, making use of (5.1) and (5.4), gives:

$$\text{(A.1)} \qquad dg \;=\; g^1{}_p.dp \;+\; (w^1-w^2)'dv^1.$$

To eliminate the changes in factor allocations from this, differentiate (5.4) and combine with (5.3) to obtain:

$$\text{(A.2)} \qquad dv^1 \;=\; (g^1{}_{vv}+f_w g^2{}_{vv})^{-1}\,[-g^1{}_{vp}dp \;+\; f_\gamma d\gamma].$$

Substituting into (A.1) and collecting terms gives the expressions we seek for the effects of price and distortion changes on GNP:

$$\text{(A.3)} \qquad g_p \;=\; g^1{}_p \;-\; (w^1-w^2)'(g^1{}_{vv}+f_w g^2{}_{vv})^{-1}g^1{}_{vp},$$

$$\text{(A.4)} \qquad g_\gamma \;=\; (w^1-w^2)'(g^1{}_{vv}+f_w g^2{}_{vv})^{-1}f_\gamma.$$

In both these equations, a key matrix is $(g^1{}_{vv}+f_w g^2{}_{vv})^{-1}$, which gives the effects of higher factor prices in sector 1, w^1, on employment levels there, v^1. In the case of absolute factor-price differentials, f_w collapses to the identity matrix and the key matrix is negative definite. But nothing can be said about its properties in general. In equation (A.3), the first term on the right-hand side, $g^1{}_p$, is the vector of outputs of import-competing goods, y^1. In the presence of distortions, this differs from the price derivative of GNP by the second term: if the matrix $(g^1{}_{vv}+f_w g^2{}_{vv})^{-1}$ is negative definite, this term tends to encourage a further increase in GNP whenever a price increase tends to raise the returns in sector 1 of those factors which are paid higher premia there (i.e., whenever the vectors (w^1-w^2) and g^1_{vp} are positively correlated). As for equation (A.4), its interpretation is straightforward when the distortions take the form of absolute price differentials, implying that a proportionate reduction in distortions will raise GNP.

A.2 Derivatives of the Output Supply Functions: $y^1(p,v,\gamma) = g^1_p\{p,v^1(.)\}$

Differentiating totally the equation for the output supply functions, making use of (A.2), gives the required derivatives:

$$\text{(A.5)} \qquad y^1_p \;=\; g^1_{pp} \;-\; g^1_{pv}(g^1_{vv}+f_w g^2_{vv})^{-1}g^1_{vp},$$

where the second term takes account of the induced factor reallocation between sectors; and:

$$\text{(A.6)} \qquad y^1_\gamma \;=\; g^1_{pv}(g^1_{vv}+f_w g^2_{vv})^{-1}f_\gamma.$$

Once again, these derivatives have a straightforward interpretation with absolute intersectoral factor-price differentials. But, more generally, as is well-known from the literature on factor-market distortions in the two-sector model, perverse price-output and distortion-output responses are possible.[21]

A.3 The GNP Function with Many Sectors

The assumption that factors are allocated efficiently within each sector allows us to specify sectoral product functions for each:

$$(A.7) \qquad g^i(p^i,v^i) \;\equiv\; \underset{x_i}{Max}\;[p^i.x^i \;:\; F^i(x^i,v^i) = 0] \qquad\qquad i = 1, \dots n,$$

where $F^i(x^i,v^i) = 0$ is the production constraint for sector i, summarising the technology there which is assumed to be convex. As for the distortions themselves, a general way of specifying them, following Jones and Neary (1991), is to extend equation (5.2) by writing the factor price vector in sector i, denoted by w^i, as a function of a vector of "free" or undistorted factor prices, denoted by w, and of a vector of sector-specific distortion

[21] As in Neary (1978), stability arguments can be invoked to place restrictions on the comparative statics responses, but their interpretation is more difficult with more than two factors or sectors.

parameters, denoted by γ^i:

$$\text{(A.8)} \qquad w^i = f^i(w,\gamma^i) \qquad\qquad i = 1, \ldots n.$$

The free factor prices w will typically be associated with the actual factor prices in at least one sector of the economy; nevertheless the symmetric specification is more convenient.

The production side of the general model is completed by adding the marginal productivity conditions:

$$\text{(A.9)} \qquad w^i = g^i_v(p,v^i) \qquad\qquad i = 1, \ldots n;$$

the full-employment constraint:

$$\text{(A.10)} \qquad \Sigma\, v^i = v;$$

and the fact that GNP equals the sum of sectoral products:

$$\text{(A.11)} \qquad g(p,v,\{\gamma^i\}) = \Sigma\, g^i(p,v^i).$$

The $2n+1$ vector equations (A.7), (A.9) and (A.10) can now be solved for the $2n+1$ vector unknowns, $\{w^i\}$, $\{v^i\}$ and w; and substituting the results into (A.11) allows us to proceed as in the text.

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	1985	1986	1987	1988	1989
Producer Subsidy $(p-p^*)/p^*$	0.32	0.28	0.63	0.39	0.01
Consumer Subsidy $(p^*-q)/p^*$	0.31	0.40	0.08	0.20	0.35
Nontraded Good Subsidy $(c-h)/c$	0.71	0.39	0.24	0.27	0.27
Fertilizer Input Subsidy $(f^*-f)/f^*$	0.69	0.68	0.64	0.59	0.55

Table 1: Primary Distortions in Maize and Fertilizer

	1986	1987	1988	1989	Cumulative 1985-89
TRI:	7.5	40.2	-40.3	-34.3	-40.9
Decomposition by Commodity:					
Maize	-3.9	38.8	-23.4	-29.3	
Sorghum	17.5	-7.9	0.7	-3.3	
Wheat	-1.3	0.4	1.0	-3.6	
Soy Bean	-2.0	5.1	-6.2	4.4	
Dry Bean	-2.9	-0.1	0.3	-0.3	
Barley	0.2	-0.3	0.3	-0.2	
Cottonseed	0.3	5.4	-11.1	-0.8	
Sesame Seed	0.0	0.3	-0.1	0.4	
Sunflower Seed	0.0	0.0	0.0	0.0	
Coffee	0.1	0.0	0.4	-0.1	
Fertilizer	-0.5	-1.5	-2.0	-1.4	
Decomposition by Policy Instrument:					
Production Subsidy	7.1	43.4	-41.4	-28.7	
Consumption Subsidy	0.9	-1.6	3.2	-4.2	
Input (Fertilizer) Subsidy	-0.5	-1.5	-2.0	-1.4	
Comparison of True and Ad Hoc Sub-Indices:					
PSE	-7.4	2.4	-4.9	-5.9	-15.1
Δ^p	7.1	34.4	-31.6	-30.1	-31.2
CSE	-6.4	15.3	32.5	-31.0	-1.3
Δ^q	-79.8	-11.4	69.7	-7.9	-72.0

Table 2: The TRI and its Components
(% changes per annum)

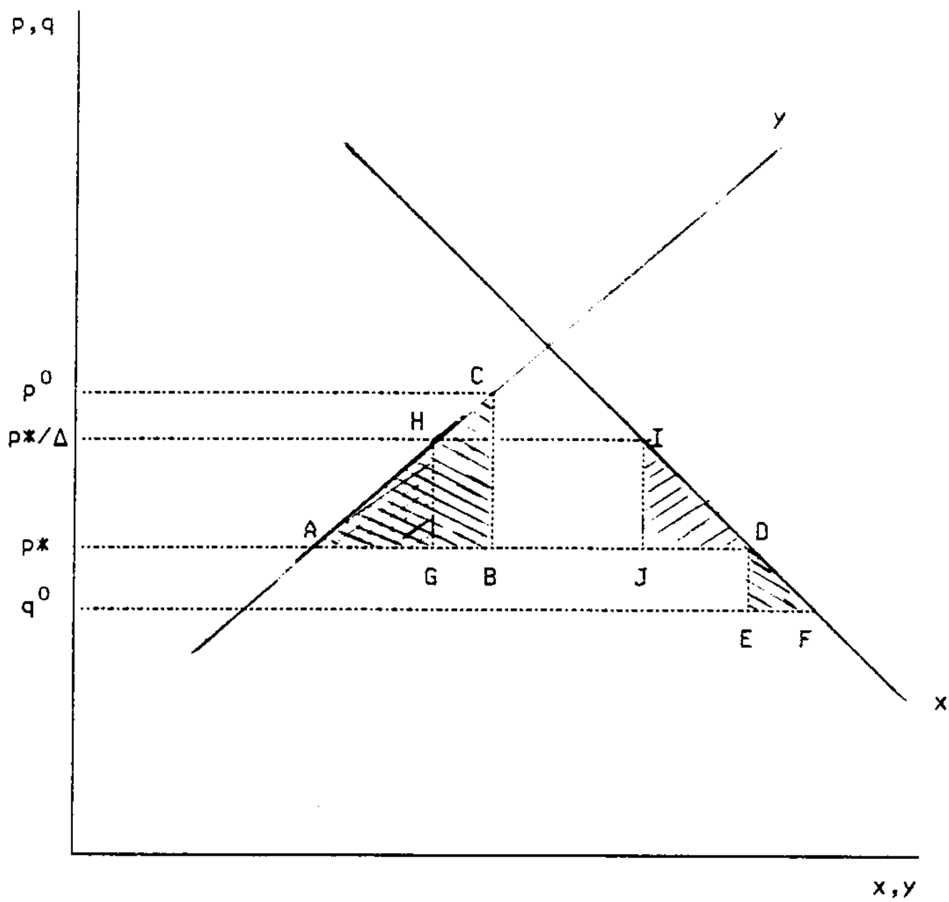

Figure 1: The Tariff Equivalent of a Producer and Consumer Subsidy Combined