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The Trade Restrictiveness Index

An Application to Mexican Agriculture

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and
Geoffrey Bannister

Applying a new trade restrictiveness index to policy reform in Mexican agriculture shows substantial trade liberalization between 1987 and 1989, attributable mainly to changes in maize policy.

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To measure domestic distortions in agriculture, analysts have used producer and consumer subsidy equivalents (PSEs and CSEs), as well as the familiar trade-weighted averages of tariffs and tariff equivalents of quotas. All these indices lack a theoretical foundation.

Anderson and Bannister apply a new concept, the trade restrictiveness index, to an evaluation of Mexican agricultural reform. They assess a significant reform episode to demonstrate the feasibility of the method and its advantages over standard techniques.

Anderson and Bannister set out the theoretical structure of index numbers for distorted trading economies in earlier papers. They develop an index number for trade distortions: the uniform tariff, which is equivalent in trade restrictiveness to the actual differentiated structure of tariffs and quotas. To extend the index to domestic distortions, they draw on the well-known equivalence between a tariff and an equal level of producer subsidy and consumer tax (when imported and domestically produced goods are perfect substitutes).

The trade restrictiveness index for domestic distortions is defined as the uniform tariff equivalent of the consumption and production distortions. It is, in turn, a combination of two subindices: the consistent producer subsidy equivalent (CPSE) and the consistent consumer subsidy equivalent (CCSE). These are defined as the uniform subsidy rates that are equivalent in trade restrictiveness to the actual differentiated subsidy or tax structure. They are counterparts to the PSE and CSE. The difference between the consistent and conventional subindices is in the method of aggregation. Consistent aggregation is based on the use of "marginal welfare weights" as opposed to production and consumption share weights.

In Mexico, from 1985 to 1989, the target producer and consumer price policies for major crops reveal many simultaneous increases and decreases in implicit subsidies or taxes. The trade restrictiveness index provides a consistent aggregation of these policies. From 1985 to 1987, domestic policy on the whole was equivalent to an increase in trade restrictiveness. In the next two years, trade loosened.

The net effect of policies in tradable agricultural goods over the five-year period is a significant reduction in trade restrictiveness. Restoring the trade restrictiveness to its 1985 level requires a uniform 31-percent trade tax surcharge on 1989 prices. Moreover, the restrictiveness implied by the 1989 levels, compared with free trade, was equivalent to a 17 percent ad valorem trade tax. Thus, the liberalization of the 1985-89 period carried Mexican agriculture more than halfway to free trade.

One virtue of the index is that the sources of liberalization can be detailed. Liberalization is attributable mainly to changes in maize policy, despite substantial changes in other producer and consumer price policies. Reducing the subsidy for fertilizer use was relatively unimportant.

The standard PSE and CSE index methods are not directly comparable to the trade restrictiveness index, as they do not aggregate consumer and producer distortions. The PSE and CSE indices are, however, comparable to the consistent subindices CPSE and CCSE. The rates of change of these two types of indices are only weakly positively associated, differ in sign in a quarter of the cases, and in most cases differ widely in magnitude.

The implications of the consistent index of the change in consumer policy are diametrically opposed to the implications of the CSE over the five-year period. Using the trade restrictiveness index thus makes a great practical and a theoretical difference.

The Trade Restrictiveness Index: An Application to Mexican Agriculture

James E. Anderson* Geoffrey Bannister**

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The Trade Restrictiveness Index: An Application to Mexican Agriculture

Agricultural markets in Mexico, as elsewhere, are distorted by domestic subsidies as well as international trade policies. To measure domestic distortions in agriculture and compare them internationally, analysts have used 'producer subsidy equivalent' (a production-share weighted average of producer subsidies) and 'consumer subsidy equivalent' indices, as well as the familiar trade-weighted averages of tariffs and tariff equivalents of quotas. All these indices lack a theoretical foundation, as is well-known. Moreover, in the absence of a connection between the three partial indices of consumption, production, and trade distortion, inferences about the trade restrictiveness of all three policies are illegitimate. This paper applies a new concept, the trade restrictiveness index (TRI), to the evaluation of Mexican agricultural reform from 1985 to 1989. It demonstrates the feasibility of the new method and its theoretical and practical advantages over standard techniques, while at the same time providing an assessment of a particularly significant reform episode.

The theoretical structure of index numbers for distorted trading economies is set out in two papers by Anderson and Neary (1991a,b). The basic idea is to form an index number equal to the uniform tariff factor which is equivalent in trade restrictiveness to the differentiated structure. The former paper (1991a) defines the trade restrictiveness index for the case where all distortions are trade taxes or quotas.[1] The latter paper (1991b) extends the index to the case where domestic distortions break the equality between consumer and producer prices. It draws on the well-known equivalence between a tariff on the one hand and an equal rate of production subsidy and consumption tax on the other (for an imported good which is a perfect substitute for a domestically produced good). The trade

[1]In our earlier work with quotas, Anderson and Neary (1990), we used the term "coefficient of trade utilization" reflecting the relationship of the index to the work of Debreu (1951).

restrictiveness index in this case is the uniform tariff factor which is equivalent in trade restrictiveness to the consumption and production distortions. The trade restrictiveness index is in turn a combination of two subindices, the 'consistent producer subsidy equivalent' (CPSE) and the 'consistent consumer subsidy equivalent' (CCSE). These we define as the uniform subsidy rates which yield equivalent trade restrictiveness to the actual differentiated subsidy or tax structure. They are counterparts to the producer and consumer subsidy equivalents, PSE and CSE. The difference between our subindices and the conventional ones is in the method of aggregation. Our consistent aggregation is based on the use of 'marginal welfare weights' as opposed to production and consumption share weights.

The trade restrictiveness index is comparable across countries and time in the same way (and with the same qualifications) that inflation rates or real growth rates are internationally or intertemporally comparable. By reducing many distortions to a single uniform trade tax equivalent, analysts can legitimately compare the international trade implications of the domestic agricultural policies of a set of countries. Thus it achieves the goal of the PSE and CSE measures as they have been used in GATT negotiations.

The application of the TRI to Mexican agriculture reveals the usefulness of our method. From 1985 to 1989, the target producer and consumer price policies for major crops reveal many simultaneous increases and decreases in the implicit subsidies or taxes. The trade restrictiveness index is a consistent aggregator of these policies. From 1985 to 1987, the changes in domestic policies were equivalent to an increase in trade restrictiveness, followed by a decrease in trade restrictiveness in the next two years. The net effect of policies in tradable agricultural goods over the 5 year period is a significant reduction in trade restrictiveness. Restoring the trade restrictiveness to its 1985 level requires a 31 per cent uniform trade tax surcharge on the 1989 prices. Moreover, the restrictiveness implied by the 1989 levels compared to free trade is equivalent to a 17 per cent uniform ad valorem trade tax. Thus the liberalization of the 1985-89 period carried the Mexican agricultural sector about two thirds of the way to free trade. Another virtue of the index is that the sources of this development are easily detailed. It is mainly accounted for by maize policy, despite substantial changes in other producer and consumer price policies. The reduction in the subsidy to fertilizer use, in particular, accounted for very little.

Our method provides results which differ widely from those of the standard PSE and CSE index methods. The PSE and CSE indices are comparable to the consistent subindices of the TRI, the CPSE and CCSE. The rates of change of the subsidy equivalents and their consistent counterparts are only weakly positively correlated, differ in sign in one quarter of the cases, and differ widely in magnitude in most cases. Dramatically, the consistent index of the change in consumer policy gives implications diametrically opposite to the CSE over the 5 year period. Use of the TRI thus makes a great practical as well as theoretical difference.

The outline of the paper is as follows. Section I defines the trade restrictiveness index for an economy with domestic distortions, following Anderson and Neary (1991b). Section I also defines the consistent versions of the PSE and CSE, the CPSE and CCSE, and compares the latter with the former. The trade restrictiveness index (TRI) is shown to be a weighted average of the CPSE and CCSE. Section II sets out a description of the Mexican agricultural sector and the data used for this study. Section III presents our results covering the period from 1985 to 1989. Section IV provides perspective on the results. We compare our results with those generated by standard methods, and we test the sensitivity of our results to elasticity parameters and to measurement problems. Section V concludes.

I. The Trade Restrictiveness Index

Changes in index numbers are generally weighted averages of changes in the components of the index. To be consistent with economic theory, the weights must arise from a fundamental economic structure. It is helpful to begin with reviewing the consumer price index, or CPI where the weights are familiar. Subsection I.1 derives the consumer price index based on the consumer's expenditure function. In Subsection I.2, the trade restrictiveness index, or TRI, is derived based on the economy's trade balance function. The latter is defined in Anderson and Neary. Here, the weights are less familiar, but the same logic girds the construction of the index. Subsection I.3 extends the analysis to the case of domestic distortions. Subsection I.4 relates the TRI to the PSE and CSE. Subsection I.5 extends the index to cover the trade restrictiveness effect of distortions in purely nontraded goods.

I.1 The Consumer Price Index

A set of consumer prices changes. The consumer price index (CPI) in rates of change measures the *uniform* rate of change in all prices which produces an equivalent rise in the expenditure required to maintain welfare. The formal basis for the CPI is the consumer's expenditure function, $e(q,u)$, where q is the vector of prices and u is the reference level of utility. e is the minimum level of income required to achieve u when the consumer faces q. The CPI is derived as follows. The derivative of e with respect to q is equal to the vector of the consumer's demands, X. The effect of an arbitrary set of price changes on the level of income required to support u is then $X'dq$. The effect of a *uniform proportional* set of changes is $X'q^0 d\alpha$, where α is the (scalar) proportionality factor ($q = \alpha q^0$, where q^0 is the initial level of prices). Solving for the uniform proportional change in q which creates the same rise in required expenditure as the arbitrary change in q implies $d\alpha = X'dq/X'q$, or

$$(1.1) \quad d\alpha \quad = \quad \Sigma\left(\frac{X_i q_i}{X'q}\right)\hat{q}_i.$$

Initially α is equal to one, so $d\alpha$ is a percentage change. This familiar expression weights the proportionate change (denoted by a ^) in each q_i by the consumption share of good i.

To link the CPI firmly to our work requires a somewhat less familiar step. Suppose that instead of a compensating rise in income, we ask what uniform proportionate change in prices will compensate for (i.e. offset) the change in prices dq. In this case we define a version of (1.1) which has opposite sign:

$$(1.1') \quad d\alpha' = -\Sigma\left(\frac{X_i q_i}{X'q}\right)\hat{q}_i.$$

The opposite sign denotes the compensatory change in hypothetical prices. This latter form is the one we work with.

I.2 The Trade Restrictiveness Index

A set of trade restrictions changes. This will alter the foreign exchange required to maintain the utility of a representative consumer. The trade restrictiveness index measures the *uniform* rate of change of the trade distortions which yields a compensating (i.e. fully offsetting) change in the foreign exchange required to maintain welfare. In other words, the balance of trade measured in foreign prices is maintained by (i) using the new levels of trade restrictions, (ii) simultaneously compensating with a uniform change in trade restrictions, all the while keeping welfare at its initial level. In Anderson and Neary (1991a) we consider an index of tariffs, and of tariffs and quotas simultaneously. The formal basis is the (general equilibrium) trade balance function, which gives the net foreign exchange required to maintain the utility of a representative consumer facing given levels of tariffs or quotas. For tariffs the trade balance function is B(p,u), which gives the net foreign exchange required to support the initial level of utility u when the new vector of tariffs is equal to p-p*, where p and p* are the domestic and international prices of output. Presently we shall use some of its properties, following Anderson and Neary. Appendix 1 develops the special case used here for the evaluation of Mexican agriculture.

The trade restrictiveness index is based on first noting that the utility-constant change in the foreign exchange requirement (the trade deficit measured in terms of foreign prices) due to a change in p is equal to $B_p'dp$. Here, and in the remainder of the paper we adopt the convention that a subscript denotes partial differentiation, save where it explicitly refers to a commodity type. The *uniform proportional* change in p which offsets the change in B is $-B_p'p^0d\Delta$. Solving for the uniform proportional change in p which is equivalent in trade restrictiveness to the arbitrary change dp,

$$(1.2) \quad d\Delta \quad = \quad -\Sigma\left(\frac{B_{pj}p_j}{B_p'p}\right) \hat{p}_j.$$

Note the similarity of structure of (1.1) and (1.2). A more general definition is used in index theory to define an index even when the values of p^1 are far from the initial point p^0. Thus:

$$(1.3) \quad \Delta(p^1,u^0,r^0) \quad = \quad \{\Delta \mid B(p^1\Delta,u^0) = r^0\}.$$

Here, r^0 is the initial foreign exchange requirement (trade deficit), and the constraint requires Δ to change as p changes so as to maintain a constant trade deficit at the given u^0. The most intuitive interpretation arises when the new value of p is equal to p*. Then Δ is equal to one plus the uniform ad valorem tariff rate which is equivalent in restrictiveness to the initial tariff structure. Elsewhere, Δ is equal to the uniform tariff factor *surcharge* which compensates for (offsets the change in trade restrictiveness implied by) the move to a new tariff structure. Note that under definition (1.2), the compensating change in foreign exchange induced by Δ is just sufficient to maintain u^0 when prices shift to p^1. Thus Δ is a compensating variation measure of the welfare effect of the change, and we may interpret Δ as the uniform tariff surcharge which is equivalent in welfare to the change to the new prices. Intuitively, it is the increase in the uniform tariff that just compensates for a liberalization of domestic prices.[2]

While the level of Δ is most interesting for policy interpretation, the method of obtaining it used here involves accumulation from local changes. The rate of change of Δ from (1.3) is equal to:

$$(1.2') \quad \hat{\Delta} \quad = \quad \frac{d\Delta}{\Delta} \quad = \quad -\Sigma\left(\frac{B_{pj}p_j}{B_p'p}\right) \hat{p}_j.$$

Equation (1.2') is made operational by identifying the partial derivatives B_{pj} (the negative of the marginal cost of tariffs) which allow us to calculate the 'marginal welfare weights'

[2]It is also possible to define an equivalent variation measure but we do not pursue this here.

$B_{pj}p_j/B_p'p$. B_p is identified in our cited work.[3] We assume here that the economy is small, so that foreign prices are exogenous, and equal to p*. Intuitively, B_p is based on the familiar notion that a change in a tax is harmful according to its impact on the level of the distorted activity times the size of the distortion. To see what is involved, first suppose that a single traded good is subject to a tariff and there are no other distortions in the economy. The domestic price of the import is p. The tariff is equal to p-p*. The consumption of the good is equal to X, the production is equal to Y, and imports are X-Y. The net foreign exchange required to maintain a constant utility, $B_p dp$, is equal to $-(p-p^*)(X_p - Y_p)dp$. Here, $(X_p - Y_p)$ is the derivative of the import demand function with respect to the domestic price and the change in the distorted activity is equal to $(X_p - Y_p)dp$. B_p is positive in the one good case, provided imports are taxed ($p>p^*$), since $(X_p - Y_p)$ is negative. This means that a rise in the tariff will increase the foreign exchange required to maintain u; i.e., it is welfare-decreasing in the usual terminology. Integrating $(p-p^*)(X_p - Y_p)dp$ from p equal to p* up to p* plus the initial setting of the tariff yields the familiar dead weight loss triangle.

For the many goods case, p, p* and (X-Y) are all vectors, and $(X_p - Y_p)$ is the matrix of import demand derivatives. The row vector of marginal dead weight losses is

(1.4) $$B_p' \quad = \quad -(p-p^*)'(X_p - Y_p).$$

The elements of B_p' are expected to be positive, but cross effects can make some elements negative.

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[3]For quotas, our index number, the coefficient of trade utilization, is based on first noting that the welfare-preserving foreign exchange requirement of a change in Q is $B_Q'dQ$. The uniform proportional change in Q which produces the same change in B is $B_Q'Qd\alpha$. Solving for the uniform proportional change in Q which is equivalent in welfare to the arbitrary change,

$$d\alpha \quad = \quad \Sigma\left(\frac{B_{Qj}Q_j}{B_Q'Q}\right)\hat{Q}_j.$$

This expression is made operational by identifying the partial derivatives B_{Qj} (the negative of the shadow price of quotas) which allow us to calculate the weights $B_{Qj}Q_j/B_Q'Q$. They may be termed marginal welfare weights. B_Q is identified in a number of cases in our cited work. In the case where quotas alone distort, $-B_{Qj}$ is equal to the unit quota premium, $p_j-p^*_j$.

For the realistic case where an export is taxed (as with coffee in Mexico), equation (1.4) is still the formula for the effect of a rise in the domestic price of the exportables upon the net foreign exchange required to support the initial utility. The export tax is equal to p^*-p. A rise in the export tax will lower p for a small country. We must therefore redefine the index with taxation of exports so that it properly captures the idea of a uniform compensating change in trade restrictiveness. Thus the uniform compensating import (export) tax surcharge change is defined by:

$$(1.2'') \quad \left(B_{p_m}'p_m - B_{p_x}'p_x\right)\hat{\Delta} = B_p'dp,$$

where p is partitioned into the import price vector p_m and the export price vector, p_x. The term on the right hand side of (1.2") is the net foreign exchange effect of a uniform proportionate ad valorem surcharge for imports (raising p_m by $\hat{\Delta}$ percent) and export tax surcharge for exports (lowering p_x by $\hat{\Delta}$ per cent). The explicit definition of Δ is now:

$$(1.3') \quad \Delta(p_m,p_x,u^0,r^0) = \{\Delta \mid B(p_m\Delta,p_x/\Delta,u^0) = r^0\}.$$

While the export tax is relevant for Mexico, the exposition is eased if we return for the remainder of the theoretical discussion of Section I to the case where imports alone are distorted.[4]

I.3 Domestic Distortions

The agricultural policy problem is that a set of domestic prices, some for consumers and some for producers, are effectively fixed by the government. Simple price targets raise prices to consumers, acting like a tax, and raise prices to producers, acting like a subsidy. If the domestic consumer and producer prices are equal, the policy is equivalent to a tariff. If consumers are not rationed and producers are to sell all they produce, the tariff required is the variable levy which raises the foreign price to the domestic price target level. In the case of Mexico, the trade policy is in fact the (variable) quota which is equivalent to this: the

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[4]Import or export subsidies ($p_m<p^*_m$ or $p_x>p^*_x$) require no special treatment. All the preceding formulae apply.

quota must be equal to the difference between demand and supply at the target price. For evidence that the quota policy is not additionally restrictive, see Section II below.

For many commodities subject to target pricing in Mexico, the consumer and producer prices are not equal. Notably, many commodities have consumption subsidy programs (i.e., consumer prices set <u>below</u> the world price). In addition, the use of inputs such as fertilizer is subsidized. In this case, the production subsidy and consumption tax or subsidy must be treated separately. Let p denote the vector of producer prices and let q denote the vector of consumer prices. The tariff case is the special case where p and q are equal, and greater than p*.

The distortions enter the trade balance function B(p,q,u). The new index number problem is to evaluate a set of changes (dp, dq). The analog to the previous steps is to define an index number which equates the change in the net foreign exchange required to maintain utility, $B_p dp + B_q dq$, with the change in net foreign exchange due to a *uniform proportionate rise in p and q,* or $(B_p p + B_q q)d\Delta$. Thus the index change is equal to:

(1.5) $$\hat{\Delta} = -\sum_{j\&k} \frac{B_{pj}dp_j + B_{qk}dq_k}{B_p p + B_q q}.$$

The marginal welfare weights in this expression are based on B_q and B_p. Each element $B_{pj}dp_j$ is equal to the sum over all distorted activities of the product of the size of the distortion and the change in level of the distorted activity. The change in the level of the distorted activity is in turn obtained from the product of supply and demand derivatives times the change in the producer or consumer price due to the change in policy.

More formally, we report:

(1.6) $$B_p' = (p-p^*)'Y_p - (q-p^*)'X_p, \text{ and}$$

(1.7) $$B_q' = (p-p^*)'Y_q - (q-p^*)'X_q.$$

In (1.6), Y is the vector of production quantities and Y_p is the matrix of derivatives of production with respect to p. X is the vector of demand quantities and X_p is the derivative matrix. For final demand quantities, the elements of X_p are equal to zero, since production subsidies have no impact on final demand. For intermediate input demand quantities, however, X_p is not equal to zero, and might ordinarily be positive. For the case where production is subsidized, we anticipate that B_p is positive, although cross effects can make it negative. Correspondingly, in (1.7), X is the vector of consumption and X_q is the matrix of derivatives of consumption with respect to q. For final demands, the corresponding elements of Y_q are equal to zero. For the case where consumption is taxed, we anticipate that B_q is positive, although cross effects can make it negative.

Anderson and Neary (1991b) consider the structure of Y_p for general equilibrium models. For our application to Mexican agriculture we assume the prices of intersectorally mobile factors of production are exogenous. Thus we use partial equilibrium supply derivatives for Y_p. The cross effects in supply disappear in this case, so Y_p is a diagonal matrix. Moreover, we assume following our data on elasticities (see Section II) that cross effects in demand are absent. However, for intermediate inputs there are cross effects between supply and input demand. These arise in maize production. Similarly, a rise in the fertilizer subsidy results in a direct effect plus a cross effect. The details are given in the Appendix.

I.4 Relation to Standard Methods

Previous analysis of agricultural policy, for lack of a better alternative, has used indices of producer and consumer distortions which have no theoretical foundation. These can be related to our index. The producer subsidy equivalent (PSE) in rates of change is a production share weighted sum of the rates of change in p. The negative (to conform to our convention that the index measures the compensating change) of the rate of change of the PSE is defined by

$$(1.8) \quad -\frac{dPSE}{PSE} = -\sum \frac{(p_i Y_i)}{Yp} \hat{p}_i.$$

This may be contrasted with the consistent producer subsidy equivalent, CPSE, defined in Anderson and Neary (1991b). In rates of change it implies a measure:[5]

$$(1.9)\quad \frac{dCPSE}{CPSE} = -\Sigma \frac{(p_i B_{pi})}{B_p' p} \hat{p}_i.$$

The difference between the rate of change of CPSE and PSE is in the weights. Each individual subsidy change $\hat{p}_i$ in the rate of change of PSE is weighted by the proportion of the value of total production accounted for by that item, $p_i Y_i/p'Y$. By contrast, each individual subsidy change in the rate of change of CPSE is weighted by the proportion of the shadow value of the production distortion accounted for by that item. For each category i, the CPSE weight is based on (1.6), which with the zero cross effect restriction yields[6]

$$p_i B_{pi}/\Sigma p_i B_{pi} = \varepsilon_i (p_i Y_i)(p_i - p^*_i)/\Sigma \varepsilon_i (p_i Y_i)(p_i - p^*_i),$$

where $\varepsilon = p_i Y_{ip}/Y_i$, the supply elasticity. This should be compared to the PSE weight $p_i Y_i/\Sigma p_i Y_i$. The two are the same only if the term $(p_i - p^*_i)\varepsilon_i$ is invariant over i; an implausible condition restricting both the supply elasticities and the distribution of subsidies.

Similarly, agricultural policy analysts have used a consumer subsidy equivalent index, CSE. The basic distortions are that the vector q is less than p*. Defined to conform with our convention that the index measures the uniform compensating change in the subsidy factor, the CSE in rates of change is equal to

$$(1.10)\quad \frac{dCSE}{CSE} = -\frac{\Sigma (q_i X_i)\hat{q}_i}{X'q}.$$

This contrasts with a consistent consumer subsidy equivalent, CCSE, which in rates of change is equal to:

$$(1.11)\quad \frac{dCCSE}{CCSE} = -\frac{\Sigma (q_i B_{qi})\hat{q}_i}{B_q' q}.$$

For the same sorts of reasons, the two indices will ordinarily differ.

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[5]The theoretical version of CPSE developed in Anderson and Neary (1991b) allows for the impact of consumer taxes or subsidies. The rate of change of CPSE defined in (1.9) should be interpreted as for constant consumer policies. This comment also applies to the consistent consumer subsidy equivalent defined below.

[6]The formula used below in Mexican agriculture includes a cross effect due to the fertilizer subsidy.

The consumer tax and producer subsidy factors are indexed together in the TRI. The rate of change of Δ (suppressing nontraded goods distortions) is a weighted average of the rate of change of CPSE and minus CCSE:

$$(1.12)\quad \hat{\Delta} = -\lambda\frac{dCCSE}{CCSE} + (1-\lambda)\frac{dCPSE}{CPSE},$$

$$\text{where } \lambda = \frac{B_q'q}{\{B_q'q + B_p'p\}}.$$

λ lies between zero and one under normal conditions.

I.5 Nontraded Goods

The final adaptation needed to consider Mexican agriculture is that there are important distortions in non-traded goods. For the results reported here, the non-traded good is milled maize, which is sold at a subsidized price, and produced with inputs of whole maize which are taxed or subsidized, depending on the identity of the producer (see Section II). The methods reported here would also be useful in extensions of the model to incorporate subsidies to water usage, an important topic in Mexican and other countries' agriculture. For the nontraded good, the role of the external price p* is taken over by the domestic marginal cost, c. It is assumed that consumers are not rationed (which seems to accord with the Mexican experience with fertilizer subsidies in agriculture), in which case the (implicit) subsidy rate in maize is equal to the marginal cost less the target price divided by the marginal cost. With the nontraded good requirement that domestic supply be equal to demand, a cross effect arises due to the rise in the final consumer subsidy altering the demand for subsidized whole maize as an input. The Appendix contains further details.

The trade restrictiveness index must now be extended to incorporate the implication of purely nontraded goods subsidies. Let h denote the consumer price in the nontraded good sector. The TRI is implicitly defined by:

$$(1.13)\quad \Delta(p^1,q^1,h^1,u^0,r^0) = \{\Delta \mid B(p^1\Delta,q^1\Delta,h^1,u^0) = r^0\}.$$

In (1.13), note that the index Δ is defined by multiplying q and p but not h, which is due to the index being an index of <u>trade</u> restrictiveness, including the effect on the trade balance of a purely domestic policy such as the milled maize subsidy.

The rate of change of the TRI is obtained from differentiating the trade balance with respect to the policies in (1.13):

$$(1.14)\quad \hat{\Delta} = \frac{-\{\Sigma(q_iB_{qi})\,\hat{q}_i + \Sigma(p_jB_{pj})\,\hat{p}_j\}}{\{B_q'q + B_p'p\}} - \frac{(1/\Delta)\Sigma(h_kB_{hk})\,\hat{h}_k\}}{\{B_q'q + B_p'p\}}$$

where ^ denotes percentage change in the relevant variable. The first term in (1.14) is the tradeable goods policy component of the proportionate change in the index Δ. The second term is the contribution of changes in nontraded goods subsidy policy to the index Δ. Thus, it evaluates the welfare effect of changes in domestic subsidies in terms of their effect on the uniform tariff equivalent of the policies.

Equation (1.13) can be solved implicitly for the level of Δ in a computable general or partial equilibrium model. Below, we present a partial equilibrium version. Here, we treat equation (1.14) as a differential equation of degree one, and solve for Δ using the initial normalization condition that Δ be equal to one in order to tie down the constant of integration. We use this technique for calculating the levels of the TRI with and without the nontraded goods subsidy. Let the first term on the left hand side of (1.14) be equal to -a, and the second term be equal to -b/Δ. Multiplying both sides of (1.14) by Δ, we have $\frac{d\Delta}{dx}$ $= -a\Delta - b$, which solves for Δ(x) as:

$$(1.15)\quad \Delta(x) = \left(\Delta(x-1) + \frac{b}{a}\right)e^{-ax} - \frac{b}{a}.$$

This may be applied to each interval of change (with different values of a and b).

II. Mexican Agricultural Distortions

Mexican agricultural trade policies are intricately intertwined with domestic price supports and consumer subsidies. For most important Mexican agricultural imports (maize, wheat, sorghum, and oil seeds, for example), both producer and consumer or user prices are ensured through state intervention in agricultural markets. Imports are regulated through a system of licenses.[7] Two exports, coffee and sesame, are subject to producer price supports, with export control ensuring an implicit export tax in the case of coffee, and an implicit export subsidy in the case of sesame seed. Finally, a variety of input subsidies are offered to farmers. The TRI offers a way to consistently aggregate all these distortions into a single index number of the restrictiveness of the implied trade policy.

Table II.1 Mexican Agricultural Imports
(percentage - excluding livestock and dairy products)

	1985	1986	1987	1988	1989	1990
Total	100	100	100	100	100	100
Barley	0.4	0.1	0.0	0.0	1.8	1.4
Dry Beans	4.6	11.3	2.2	1.9	4.0	12.2
Maize	20.9	22.6	34.4	24.6	19.5	25.6
Oth. Oil Seeds	17.4	20.1	13.8	8.9	9.7	7.5
Cotton Seed	1.0	0.3	0.6	1.0	1.6	3.1
Soybean	22.5	22.8	26.7	24.7	22.9	19.0
Sorghum	21.6	10.7	7.5	8.8	19.2	19.0
Wheat	2.6	2.7	4.4	12.9	5.3	2.5
sum covered	90.8	90.7	89.6	82.9	84.0	90.1

Source: Banco de México, Indicadores del Sector Externo.

In this section we review Mexican agricultural policies affecting agricultural trade. Our study includes the ten principal crops in Mexican agriculture, and fertilizer. Eight of these (maize, sorghum, wheat, soybean, dry beans, barley, cottonseed, and sunflower seed), make up between 80 and 90 percent of the value of Mexican agricultural imports between 1985 to 1989 (Table IV.1). The two remaining crops are net exports, with coffee making up between 30 and 40 percent of export value, sesame seed about 1 percent. We concentrate here on policies for the most important commodities: maize, and sorghum. These crops are representative of the main policy mechanisms at work in the sector.

II.1 Institutional Description

[7]Agriculture throughout the 1985-89 period of our study remained protected by licensing requirements. It accounted for nearly half of the domestic tradeables production (excluding petroleum) in Mexico which was protected by licensing requirements. Imports subject to licensing requirements represented about 40 percent of Mexican agricultural production, and over 80 percent of the value of agricultural imports.

Because of the strategic importance of agriculture, the government of Mexico has regulated the production, distribution and consumption of principal crops through the National Basic Foods Company (CONASUPO, the second largest non-financial state-owned enterprise after PEMEX - the state owned oil company). CONASUPO is charged with the protection of producer and consumer interests through the regulation of markets for basic foods. Up to 1990, it was involved with every aspect of food production, including the procurement of crops, the storage and distribution of grains, food processing, and retail distribution. These functions were carried out by its affiliate companies: four food processors (ICONSA, LICONSA, MICONSA, and TRICONSA for oilseed, milk, maize, and wheat products respectively), two grain storage and distribution companies (ANDSA and BORUCONSA), and two food marketing companies (IMPECSA and DICONSA).

In producer markets, CONASUPO was responsible for maintaining price supports for principal agricultural commodities by offering to purchase them at guarantee prices. Until 1990, maize, wheat, rice, sorghum, beans, soybeans, and oil seed had guarantee prices. After this year they were eliminated for all commodities except maize and beans, and replaced by "consensus" prices based on negotiation between the government, producers, and food processors.

CONASUPO also imported agricultural products to supplement domestic supply, enjoying a monopoly in this area until 1985. Since then, private food processing firms have been allowed to import all commodities except beans and dehydrated milk (still reserved exclusively for CONASUPO), but always subject to import licensing requirements. These were used to maintain the domestic price of grains at the guarantee price. If the volume of licensed imports just suffices to fill the gap between the quantity demanded at the consumer price and the quantity supplied at the producer price, trade is not effectively constrained at the margin. Based on the evidence, this is the case in Mexico. Yearly price data for grains shows that producer prices generally are close to the corresponding support prices. The analysis of Mexican agricultural policy reported in Sections III-IV is thus based on assuming that the relevant distortions take place in domestic producer and consumer prices in the form of implicit subsidies.

In addition to subsidizing farmers, CONASUPO subsidized food processors by selling certain agricultural products to processors at a price below the guarantee price, and by absorbing the costs of transportation, and storage. Direct subsidies to consumers are also implemented by selling foods processed by CONASUPO at subsidized prices. Before 1985, these low food prices benefitted all urban consumers. Since then, CONASUPO has attempted to reduce these subsidies allowing consumer prices for staple foods to rise, and the system has been replaced with targeted subsidies for the very poor.

By far the largest crop and processing industry subsidy administered by CONASUPO goes to the maize sector. Maize is the primary element of the Mexican diet, and the principal agricultural crop. It takes up slightly over half of the cultivated area in the country, and results in slightly under half of agricultural production. The first component is a subsidy to farmers via the traditional price support. CONASUPO and the private processors purchase maize grain from these farmers at a price (p) above the international price (p*). On average, from 1985 to 1989 the domestic price was 12 percent above the international price, although the gap varied significantly from year to year (Table II.2).

Table II.2 Prices in the Mexican Maize Sector
(pesos/ton)

	Producer Price p	International Price p*	Subsidized Intermediate Price n	Rest of Mexico Unsubsidized Price c	"Coupon" Subsidized Price hc	Urban Subsidized Price hs
1985	52588	39696	27212	87714	16745	25517
1986	94050	73497	44015	91701	22527	55619
1987	233542	142920	131650	169049	25517	129179
1988	390882	280262	224070	299025	25517	219285
1989	437688	433433	280442	299025	25517	219285

Source: Abasto y Comercialización de Productos Básicos, CONASUPO, INEGI, SECOFI, and CONASUPO updates. p and p* include distribution margins.

The second component of the subsidy appears in the distribution of maize by CONASUPO to small processors, who manufacture "nixtamal" dough for tortilla production. "Nixtamal" is the traditional mixture used to make tortillas, either by hand or in small neighborhood production units. These small producers supply approximately 20 percent of the processed maize consumed in Mexico, principally in the Federal District (Mexico City). They receive their input from CONASUPO at a subsidized price (q) below the international price p*, to compensate for the fact that they must sell their output at the controlled urban price (hs). CONASUPO also absorbs the cost of transportation, storage, and losses, as well as administrative overhead for these small processors.

The remaining subsidies are in final consumption. Here there are two regulated prices, and one free price for milled maize products. Consumers in the Federal District can buy tortillas at a controlled price (hs). Despite proposals in 1986 to eliminate the global subsidy transferred through this lower price, these consumers continue to pay less than those outside of the nation's capital. The second regulated price was instituted for a targeted subsidy program (known as the "coupon" or "tortibono" program), which allows the very poor in all parts of Mexico to purchase maize products at the most subsidized price (hc). This program was instituted in May of 1986, and replaced a similar program (the "tortilla empacada" program) that existed throughout 1985. This subsidy is ignored in our study, since it has no distortionary impact.[8] Finally, there is the unregulated price (c) for consumers outside the Federal District who do not qualify for the coupon program.

Sorghum has also traditionally had one of the largest subsidies administered by CONASUPO. Sorghum is primarily used for animal feed, and its production takes up about 13 percent of the cultivated area and represents about 20 percent of agricultural production. For this crop, producer subsidies took the traditional form of price supports, maintaining the domestic producer price above the international price. Until mid 1989 this price support program was administered by CONASUPO, and the producer guarantee price was set by the agricultural cabinet. Since then, the price support system has been replaced by producer prices established on the basis of negotiations between producers, food processor, and the government. In addition, in 1990 the import licensing requirement for sorghum was abolished and replaced by a seasonal 10 percent ad valorem tariff (effective from October to January).

CONASUPO has also played an important, though declining, role in sorghum imports and domestic marketing. Until mid 1989 it was the primary importer of sorghum, accounting for about half of total imports. It also purchased a large part of domestic production. In turn, CONASUPO subsidized small millers by selling them sorghum at below acquisition costs, also absorbing the cost of storage, transportation, and financing.

[8] This is true so long as consumers cannot affect their coupon allocation by any economically significant action.

Table II.3 CONASUPO Participation in Total Domestic Supply (percentage)

	1985	1986	1987	1988	1989
GRAINS	35.4	31.0	33.1	46.0	29.8
Maize	22.6	26.6	24.9	29.3	25.7
Sorghum	37.8	9.8	27.3	34.6	15.6
Dry Beans	24.6	33.7	47.6	29.4	29.9
Wheat	34.0	37.4	24.0	61.8	39.1
Barley	3.8	0.0	6.5	3.6	0.0
OIL SEEDS	17.2	5.8	8.1	0.3	0.1
Soybean	25.2	8.5	10.9	0.5	0.1
Cottonseed	1.6	0.0	0.0	0.0	0.0
Sesame	2.7	5.1	0.0	0.3	0.0

Source: INEGI, Boletín de Información Oportuna del Sector Alimentario.

Price supports have also been implemented for the other crops examined in this study, although CONASUPO's involvement varies. Principal price support programs existed for soybeans, wheat, and dry beans, with CONASUPO marketing a significant percentage of total supply (Table IV.3). Barley, cottonseed, and sesame have received only sporadic support. In addition, CONASUPO's marketing subsidy was also implemented for wheat, dry beans and soybeans. Over the five years of the study, however, CONASUPO reduced its involvement in the oil seeds sector dramatically.

The production of coffee, the one significant agricultural export included in this study, is also subject to price supports. However, this program is administered by a government owned enterprise dedicated only to regulating the coffee sector: INMECAFE (Instituto Mexicano del Café). INMECAFE became much less prominent in regulating the coffee sector after the breakdown of the International Coffee Agreement's quota system in 1989. (We exclude consideration of the coffee export quota from this study because it is internationally set rather than being a Mexican government policy).[9] Before October 1989 an official

[9]The only policy choice left to Mexico is either accept the export quota or accept the alternative which would ensue if defaulted on its agreement and was subject to punishment from the remaining ICA exporters. For purposes of this study, we have therefore not included the effect of change in export quota allocations.

minimum producer price for coffee was set once a year by the agricultural cabinet. INMECAFE purchased all the coffee offered to it at this price from producers who met the dual criteria of (a) owning less than 20 hectares, and (b) having less than 5 hectares planted in coffee. INMECAFE then sold the coffee on the international market and reimbursed these small producers if any surplus funds were generated from the international sale. INMECAFE marketed about 30 percent of total coffee supply in this manner. In addition to the price support, an ad-valorem levy on coffee exports existed for sales above $139.51 per quintal (100 pounds). From 1985 to 1989 the price of Mexican coffee was well below this level and thus the export tax was non-binding (World Bank, 1990).

In addition to price supports and marketing subsidies, there are also significant subsidies to the agricultural sector administered through input prices. In this study we incorporate the use of subsidized fertilizer in the sector as a whole. Mexican farmers receive fertilizer at a subsidized price from the government owned producer FERTIMEX, which has a monopoly in the production, import, and sale of fertilizer in Mexico. However, fertilizer is not the only subsidized input. Farmers also receive subsidized credit from BANRURAL, the rural credit bank (also government owned), and subsidized crop insurance from AGROASEMEX, the government owned agricultural insurance firm. Finally, there are subsidized electric rates and subsidized irrigation. All of these subsidies can be taken into account in principle, although prices and quantities of inputs used may be difficult to obtain. In practice here, we account only for the subsidy to the use of fertilizer.

II.2 Data and Elasticities

The data required to calculate the distortion indices are those necessary to calculate the marginal shadow value of each distortion. (See Appendix 1.) This requires data on the domestic producer and consumer price, and on the foreign price of the agricultural commodity (p_i, q_i, and p_i^*, appropriately adjusted for the cost of transportation, storage, and handling), on

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The structural assumptions of this study detailed in the Appendix ensure that there is no cross effect from the policies we study which involves the value of the coffee quota rights.

the quantity of the commodity produced (Y_i), consumed, (X_i) traded (X_i-Y_i) and a set of elasticities of supply and demand with respect to price. These are simplified by our structural assumptions and the existing data to rule out cross effects. However, since since some inputs are subsidized, we require cross effects of output supply with input price changes. Prices and quantities of agricultural goods are generally available, but elasticities are more problematic.

The monthly price and quantity data for agricultural commodities were obtained principally from publications of the Mexican statistics agency (INEGI, 1990), and the agriculture ministry (SARH, 1990). Additional data were obtained from CONASUPO worksheets and from the Economic Research Service of the U.S. Department of Agriculture. Price data include distribution margins that take into account the cost of acquisition (the guarantee price for domestic supply, and the international price times the official exchange rate on the 15th of the month for imports), plus transportation, handling, and insurance. The data and sources are presented in Appendix 2.

The calculation of marginal shadow values of the distortions requires estimates of elasticities of supply for agricultural production, elasticities of input demand for the use of agricultural commodities and for fertilizer, elasticities of demand for (nontraded) final goods in the maize sector, cross elasticities of fertilizer demand with respect to the price of output and agricultural supply with respect to the price of fertilizer, and an elasticity of input demand in the maize sector with respect to changes in the price of non-traded processed maize products. The supply and input demand elasticities, as well as the final demand elasticity for nontraded goods in the maize sector, were taken from Nathan and Associates' (1990) Comermax multimarket model of Mexican agriculture. The Comermax model took these elasticities principally from econometric estimates at the Post-Graduate Agricultural Research College at Chapingo, Mexico, and from the Economic Research Service of the USDA. The input demand elasticity for the use of fertilizer in the agricultural sector was estimated, assuming a Cobb-Douglas production structure, as the production-weighted average share of fertilizer in the total cost of agricultural production. Individual crop cost shares were taken from preliminary data of the national survey on costs, technical coefficients, and yields in Mexican agricultural production, (Encuesta Nacional de Costos, Coeficientes Técnicos, y Rendimientos de la Producción Agrícola; SARH, 1985). The supply elasticity for coffee was taken from Akiyama and Varangis (1989).

The elasticities of supply with respect to the price of fertilizer were also given in Nathan and Associates (1990). These were used to derive the elasticities of fertilizer demand with respect to the price of agricultural output noting that because of the symmetry of second partial derivatives:

$$\frac{\partial Y}{\partial f} = \Pi_{pf} = \Pi_{fp} = -\frac{\partial F}{\partial m}.$$

Finally, the elasticity of input demand in the final production of maize products with respect to the price of non-traded final maize goods, $\frac{H_h h}{H}\frac{M_H H}{M}$, was calculated with a somewhat arbitrary procedure. The elasticity of final demand H with respect to the price h must be multiplied by the unknown elasticity of demand for whole maize M with respect to required final output H. A value of unity for the latter implies a degree one homogeneous cost function, which seems too high for a fixed capacity milling sector. We set the elasticity equal to the unit input requirement of maize in the production of tortilla, calculated as 0.7974 tons of maize per ton of tortilla (INEGI, 1988). This yields an elasticity of -0.23.

The following table presents the elasticity parameters used.

Table II.4 Elasticities Used in the Calculation of the TRI

Product	Own Supply Elasticity	Intermediate Input Demand Elasticity	Final Demand Elasticity	Elasticity of Supply with respect to Fertilizer input price	Elasticity of Intermediate Input Demand w/ respect to Final Price
Maize	0.58	-0.35	-0.33	-0.33	-0.23
Sorghum	0.6	-0.14	*	-0.34	*
Wheat	0.55	-0.3	*	-0.05	*
Soybean	0.42	-0.41	*	-0.1	*
Dry Bean	0.5	-0.25	*	-0.06	*
Fertilizer	*	-0.1	*	*	*
Barley	0.95	-0.25	*	-0.03	*
Cottonseed	0.5	-0.56	*	-0.04	*
Sunflower	0.5	-0.56	*	-0.1	*
Sesame seed	0.5	-0.56	*	-0.1	*
Coffee	0.02	*	*	*	*

III. The Trade Restrictiveness of Mexican Agricultural Policy

This section presents empirical results of the application of the TRI to Mexican agriculture from 1985 to 1989. It includes measures of the restrictiveness of pricing policies in the production and use of ten principal crops, and for the use of fertilizer as an input. Our results reveal the great importance of maize policy in the overall index. For this reason, and also because it is an intuitive building block, we present data for a TRI for maize alone. Its pattern conforms to, and dominates, that of the overall index. We include as well an evaluation of the trade restrictiveness effect of the subsidy to maize flour, the nontraded good. The overall TRI shows that the net effect for traded goods was to increase restrictiveness from 1985 to 1987, then to reduce restrictiveness from 1987 to 1989. The net effect over the 5 year period was a reduction in restrictiveness worth a 31 per cent uniform tariff surcharge (i.e., to compensate for the reduction in restrictiveness would require a 31 per cent tariff surcharge). Adding in the effect of the nontraded good subsidy, the net effect of the liberalization rises to a 44 per cent tariff surcharge.

Mexican agricultural policy has two main elements. The producer price support fixes agricultural producer prices and unsubsidized consumer prices (applicable mainly to the use of whole maize in the unsubsidized milling sector) above the international price, acting effectively like a tariff. The consumer price ceiling offers two targeted consumers prices below the international price. The resulting implicit tariff (the margin by which the support price exceeds the international price) and consumer subsidy (the margin by which the price ceiling falls short of the international price) are viewed here as the actual policies to be evaluated. This seems to be the most natural convention, but it means the measure we report may show a liberalization which is entirely inadvertent, due for example to an unanticipated increase in the foreign price which lowers the gap between the support price and the international price. The main alternative is to form an index based on the producer price floor and consumer price ceiling changes without regard to the international price changes. Specifically, the index we report is based on treating the changes in policy as equal to $\hat{p} - \hat{p}^*$ and $\hat{q} - \hat{p}^*$, while the alternative is to evaluate changes in policy equal to $\hat{p}$ and $\hat{q}$. Our labelling convention for presenting results refers to p policy (producer subsidies) and q policy (consumer subsidies), and for the nontraded good, h policy standing for the fixed consumer price of the nontraded good.

In subsection III.1 we present the maize TRI. The TRI is decomposed to show the relative contribution of the producer and consumer price distortions, understanding that the producer price support also affects nontargeted consumers like a tax. In subsection III.2 we present the combined TRI for all crops, with the contribution of each crop to changes in the global index and the contributions from distortions in producer prices, user prices, and inputs (fertilizer). Subsection III.3 presents the combined TRI including the effect of changes in the rate of subsidy to nontraded maize flour.

III.1 Maize Policy

Policy on whole maize has three direct components, (i) the implicit subsidy to producers, equal to (ii) the implicit tax on unsubsidized consumers, and (iii) the implicit subsidy to the regulated consumers. In addition, (iv) the subsidy to fertilizer use further distorts Mexican maize production. (Also, milled maize consumption is subsidized, a subject taken up in subsection III.3.) The data on implicit subsidies, the primary distortions, reveal wide fluctuations across time and across crops. This is illustrated below by III.1 for maize. It should be noted that in maize, the producer subsidy rate is also the tax rate for unsubsidized consumers (millers outside the regulated group). The final consumer subsidy is for the target group served by the subsidized millers (as previously noted, we neglect the coupon subsidy program since it is nondistortionary).

Table III.1. Primary Distortions in Maize and Fertilizer

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

In addition, all crops benefit from the considerable subsidy to fertilizer, which began in 1985 at 69 per cent of the world price, and fell to 55 per cent of the world price by 1989. Appendix 2 contains further details about the various price distortions.

The maize tariff equivalent of these policies toward whole maize is the TRI. In Table III.2, the figures for the contribution of changes in p and q, and the change in the TRI are continuously compounded rates of change, based on formula (1.5) applied to maize. The level of the TRI shows the level of the compensating tariff equivalent relative to its 1985 value, based on formula (1.15). The link between Tables III.1 and III.2 is as follows. From 1985 to 1986, according to Table III.1, the implicit subsidy to producers (resulting from the gap between producer prices and international prices) fell from 32 per cent to 28 per cent. This was worth a compensating increase in the ad-valorem tariff surcharge factor of 6.5 percent according to Table III.2 (the first number in the column headed 'p contribution'. This was slightly counteracted by a rise in the implicit consumer subsidy from 31 per cent to 40 per cent, leading to a net liberalization measured by an increase in the compensating tariff surcharge factor of 5.8 percent (the first number in the column headed 'change in TRI'). This works out to an increase in the level of the TRI of 6 per cent (the right column of Table III.2). The net result over the 5 years of all changes was an increase in the level of the TRI of 28.8 percent (the bottom right number less 1).

Table III.2 The Maize TRI

Year	p contribution	q contribution	Change of TRI	Level of TRI
	*	*	*	1.000
1985-86	0.065	- 0.007	0.058	1.060
1986-87	- 0.551	0.024	- 0.527	0.626
1987-88	0.291	- 0.003	0.288	0.834
1988-89	0.452	- 0.017	0.434	1.288

A similar type of analysis can be done for the other crops in our study. We summarize these results in Table III.3. (Not all crops are reported below, due to the technical difficulties of summarizing policy which effectively switches from import subsidy to import tax.) We report the TRI level over 5 years (i.e. the number comparable to the bottom right number of Table III.2). Note that for an import subsidy (fertilizer), Δ is still calculated using formula (1.5) as the compensating factor by which p must be raised or lowered to offset the foreign exchange impact of the actual change. Thus the change in policy which indicates increased restrictiveness also indicates an improvement in efficiency. For export goods (coffee, sesame seed) the formula is reversed in sign, as explained in Section I. For coffee, the value of Δ, 0.294, implies that the much lower domestic price of coffee relative to its foreign price (implying a higher export tax) must be offset by a fall in Δ from its initial level of 1. For sesame seed, the value of 1.874, indicating less restrictiveness, means that the export subsidy became greater. This, as with an import subsidy, is of course inefficient.

Table III.3

Summary Table of Crop TRI Levels, 1989

	Level of TRI (1985=1.00)	Change in Welfare
Maize	1.288	+
Sorghum	0.795	-
Fertilizer *	0.703	+
Sesame seed**	1.874	-
Coffee**	0.294	-
Soybean	1.212	+
Sunflower seed	1.617	+

(*) Import subsidy. (**) Export tax.

III.2. The Combined TRI

The results for individual commodities present a mixed picture for policy changes in Mexican agriculture. Pricing policy became less restrictive for four commodities; maize, fertilizer, soybean and sunflower seed. It became more restrictive for sorghum, sesame seed, and coffee. For dry beans, barley, wheat, and cottonseed the policies are additionally mixed because there was a regime change between import tax and import subsidy.

The combined TRI consistently aggregates distortions by weighting them with their respective share of the total dead-weight loss due to all price distortions in the sector. The index components present the contribution of each crop to the overall change of policy in the agricultural sector. Despite the presence of some import subsidization, the calculations leading to the TRI show that on balance Mexico is effectively taxing imports and exports of agriculture, in the sense that a uniform rise in traded goods domestic prices raises the foreign exchange requirement of maintaining the initial welfare level (i.e., is welfare-decreasing in the usual terminology).

Table III.4 presents the results of the combined TRI, with each individual crop component. Over the 5 year period, the agricultural sector experienced an increase in restrictiveness followed by a liberalization which culminates in a reduction in restriction sufficient to require a 31 per cent tariff surcharge to compensate for it. The commodity decomposition shows that this process is largely dominated by maize policy.

Table III.4. TRI in Agriculture and its Decomposition, 1985-89

Year	base	1985-86	1985-87	1985-88	1985-89
level TRI	1	0.927	0.620	0.928	1.307
Yearly change in TRI	*	- 0.075	- 0.402	0.403	0.343
contribution to TRI of:					
Maize	*	0.039	- 0.388	0.234	0.293
Sorghum	*	- 0.175	0.079	- 0.007	0.033
Wheat	*	0.013	- 0.004	- 0.010	0.036
Soy Bean	*	0.020	- 0.051	0.062	- 0.044
Dry Bean	*	0.029	0.001	- 0.003	0.003
Barley	*	- 0.002	0.003	- 0.003	0.002
Cottonseed	*	- 0.003	- 0.054	0.111	0.008
Sunflower seed	*	0.000	0.000	0.000	0.000
Sesame seed	*	0.000	- 0.003	0.001	- 0.004
Coffee	*	- 0.001	0.000	- 0.004	0.001
Fertilizer	*	0.005	0.015	0.020	0.014

The contributions of each crop and fertilizer to the overall change in the TRI reflect their relative importance in the agricultural sector's pricing policy. These contributions result from a weighting scheme that takes into account not only the crop's importance in overall agricultural production, but also the relative size of the distortion in each crop, and the welfare implication of changes in each crop's pricing policy. It is perhaps not surprising that maize dominates the index, given its importance in production combined with its rate of distortion. Nevertheless, the structure of the index provides no guarantee that this should be so, nor is it so in each year. For example, in the change from 1985 to 1986, the maize component differed in sign from the net change which was dominated by sorghum. It is interesting to note that fertilizer policy contributes little to the index. The fertilizer subsidy fell over the 5 year period from 69% to 55%; yet it contributes at most only 2% to the index. This is because it receives a relatively small weight.

Another useful breakdown of the components of the TRI is by producer vs. consumer distortion. Table III.5 shows the contribution of distortions in production prices, consumption (or use) prices, and the prices of inputs (fertilizer).

Table III.5 Distortion Components of the Combined TRI

Year	change TRI *	Production *	Consumption *	Inputs *
1985-86	- 0.075	- 0.071	- 0.009	0.005
1986-87	- 0.402	- 0.434	0.016	0.015
1987-88	0.403	0.414	- 0.032	0.020
1988-89	0.343	0.287	0.042	0.014

As expected, it is the price support policies in production that have the greatest weight, followed by the subsidies to the consumption or use of crops. The fertilizer price distortion has a relatively small effect on the overall change in the index. In 1985-86 both production and consumption components show a net restriction of policy, while fertilizer shows a small liberalization. In 1986-87, a large increase in restrictiveness in production pricing overwhelms liberalizations in both consumption and inputs. In 1987-88 a large liberalization in production pricing policies overwhelms an increase in the restrictiveness of consumption pricing policies. Finally, in 1988-89 there is a liberalization in in all components of pricing.

The index number method can also be used to construct the TRI implied in the move to laissez faire in agriculture. For such large changes as this is likely to cover, there are dangers in approximation error. For 1989, however, the danger is less due to the substantial liberalization already accomplished. When the TRI is calculated for a reversion to unsubsidized markets, it turns out to require a compensating uniform tariff of just 17.2 per cent, with a percentage change of the tariff factor surcharge of 15.9 per cent. In other words, the previous 5 years of liberalization have already moved nearly 2/3 of the way to 'effective free trade' in agriculture.

III.3 The Nontraded Goods TRI

The final refinement to the TRI is to include an accounting for the distortion changes in the distribution of milled maize, using formula (1.15). Looking at the implicit subsidy rate in maize flour consumption alone (see Table III.1), there was a very large reduction from a 71 per cent subsidy in 1985 to a 39 per cent subsidy in 1986, followed the next year by a further reduction to 24 per cent. The last two years reversed this by only about 3 per cent. The reduced distortion should lead to a fairly significant gain in net foreign exchange, and require a rise in the compensating uniform trade tax. The TRI confirms this. Table III.6 shows that the pattern revealed in Table III.4 is reinforced, with the liberalization over the 5 year period being sufficient to require a uniform trade tax surcharge of 44 per cent to compensate for it. As before, the increased restrictiveness in 85-87 is reversed in the last two years.

Table III.6. The TRI with Nontraded Goods Distortion

Year	Traded Goods Contribution	Nontraded Goods Contribution	Change in TRI	Level of TRI
	*	*	*	1.000
1985-86	0.075	- 0.080	- 0.005	1.005
1986-87	0.402	- 0.026	0.364	0.687
1987-88	- 0.403	0.002	- 0.401	1.025
1988-89	- 0.343	0.000	- 0.343	1.445

The commodity decomposition (not reported) shows that as before, maize policy dominates.

IV. Perspectives on the Results

How sensitive are the results of using the TRI to elasticity parameters? And how much difference does it make to use the TRI? These are the issues of this section. Our answer will be that elasticity values do not matter very much within reasonable limits, and that our index diverges substantially from the standard measure, even occasionally having the opposite implication.

IV.1. Sensitivity to Elasticities

We tested the responsiveness of individual crop TRIs and the overall TRI to variations in the supply and input demand elasticities. The responses were ordinarily quite modest. Table IV.1 presents the results for maize, which are typical.

Table IV.1 Sensitivity of TRI to Maize Elasticity Parameters

Supply El.	Demand El.	Fertilizer Cross El.	Maize TRI Level	Global TRI Level	% Variation Over Base
0	-0.35	-0.325	1.291	1.354	0.036
0.15	-0.35	-0.325	1.29	1.34	0.025
0.29	-0.35	-0.325	1.289	1.328	0.016
0.58	-0.35	-0.325	1.288	1.307	0
0.75	-0.35	-0.325	1.288	1.297	0.008
0.95	-0.35	-0.325	1.287	1.287	0.015
0.58	0	-0.325	1.269	1.331	0.018
0.58	-0.1	-0.325	1.275	1.324	0.013
0.58	-0.35	-0.325	1.288	1.307	0
0.58	-0.5	-0.325	1.296	1.299	0.006
0.58	-0.75	-0.325	1.31	1.287	0.015
0.58	-0.95	-0.325	1.322	1.279	0.021
0.58	-0.35	0	1.202	1.289	0.014
0.58	-0.35	-0.1	1.324	1.306	0.001
0.58	-0.35	-0.325	1.288	1.307	0
0.58	-0.35	-0.5	1.282	1.303	0.003
0.58	-0.35	-0.75	1.278	1.289	0.014
0.58	-0.35	-0.95	1.276	1.294	0.01

The very modest changes in results with respect to fairly large elasticity perturbations should give us confidence that the TRI is robust with respect to the single greatest source of measurement error.

IV.2 Comparison with Other Indices

In section I we presented welfare consistent counterparts to the standard measures of agricultural distortions in producer, consumer, and input prices. Here we present calculations for these consistent producer and consumer subsidy equivalents, and compare them to the more commonly used measures, the PSE and CSE. The PSE is calculated as a factor which gives the value of the subsidy over and above the value of production. The compensating change in the PSE factor (the negative of its growth rate) is the rate of change of the subsidy that compensates farmers for the shift in relative prices. Hence it is directly comparable to the rate of change of its consistent counterpart, the CPSE.

Table IV.2 gives the results of the comparison of PSE and CPSE indices.

Table IV.2 PSE and CPSE Comparison

Year	Compensating Change in the PSE Factor	Level of Compensating PSE Factor	Compensating Change in the CPSE	Level of Compensating CPSE
	*	1.000	*	1.000
1985-86	0.074	1.077	- 0.071	0.932
1986-87	- 0.024	1.052	- 0.344	0.661
1987-88	0.049	1.105	0.316	0.907
1988-89	0.059	1.172	0.301	1.225

Note that the change in the PSE and CPSE differ in sign in one case, and in magnitude in all cases. In contrast, the cumulative effect of 5 years of changes in production subsidies is fairly close in both cases, indicating a liberalization (reduction in production subsidy) of 17.2 to 22.5 per cent. This closeness of effect obviously cannot be relied on in general, as the structure of the next results shows.

For the CCSE and CSE comparison, based on Section I, Table IV.3 shows that the

Table IV.3. CSE and CCSE Comparison

Year	Compensating Change in the CSE Factor	Level of Compensating CSE Factor	Compensating Change in the CCSE	Level of Compensating CCSE
	*	1.000	*	1.000
1985-86	0.064	1.066	0.798	2.222
1986-87	- 0.153	0.915	0.114	2.489
1987-88	- 0.325	0.661	- 0.697	1.240
1988-89	0.310	0.902	0.079	1.342

rates of change of the CSE and CCSE also differ in sign in one period out of four, and in magnitude in all periods. Here, the cumulative effect is to give opposite implications for the entire 5 year period, the CCSE recording a reduction in subsidization (of about 34 percent) and the CSE an increase (of about 10 per cent).

Another perspective on the comparison of our component subindices with the PSE and CSE is to ask within what percentage interval around the PSE and CSE can the corresponding consistent index be found. Table IV.4 gives the results.

Table IV.4. Accuracy of PSE and CSE

	PSE or CSE Prediction within interval of:		
	300%	200%	100%
Probability of Success	0.625	0.5	0.125

The entry in the table is the proportion of sample observations for which the interval based on the CSE or PSE plus or minus x per cent of itself would contain the corresponding CCSE or CPSE. The data of the preceding two tables shows that none of the consistent index numbers lie within 75% of the standard numbers in either direction, and only one of eight within 100% of the standard number in either direction (accounting for the entry of a probability of 0.125). Examining Tables IV.2 and IV.3, these errors are similar for both

PSE and CSE. Thus the closeness of the PSE and CPSE levels in 1989 is a case of errors cancelling out, and may be dismissed as a fluke.

These results clearly indicate that the component subindices behave very differently from the standard indices. Inference from the PSE and CSE indices is seldom within any reasonable distance of the consistent indices.

V. Conclusion

This study has applied the trade restrictiveness index to the evaluation of Mexican agricultural policy from 1985 to 1989. The index shows that the net effect of the many policy reversals (often perhaps inadvertent as international prices overtook domestic support prices) was a substantial liberalization worth about a 31 percent tariff surcharge as compensation. Moreover, the remaining distance to effective free trade was equivalent to a compensating uniform trade tax of approximately 17 per cent. Other key results are that the main force in the overall policy was maize policy, that the addition of the trade restrictiveness effect of the subsidy to nontraded milled maize raised the liberalization effect from 1985 to 1989 to a 47 per cent tariff surcharge, and that sorghum policy in some years was significant while fertilizer subsidies were never significant.

The significance of the results goes well beyond the specific payoff to understanding Mexican agricultural policy, important though this may be. (i) By converting domestic subsidies and taxes to readily interpreted trade tax equivalents, the TRI allows international comparison of these distortions on the same basis as other trade distortions. (ii) This study shows TRI calculations are feasible for typical amounts of data. (iii) Even if the international comparability of domestic subsidies is accepted, the standard indices of producer and consumer subsidies are shown to be highly unreliable guides to even what they presumably attempt to measure. (iv) Results are robust with respect to variations in elasticity parameters, hence we may have confidence in the calculated TRIs.

Future work should take two paths. First, it is very desirable to have other TRI measures of national agricultural policy. In the context of the North American Free Trade Agreement negotiations, they should include Canada and the US. In the context of Uruguay Round concerns, they should include the EC and Japan. Besides the payoff to policy-making, more experience with the index should teach us more about its properties. Second, it would be desirable to extend the model to explore the trade restrictiveness incidence of other subsidies, such as those to water use and capital. Third, it would be useful to admit some aspects of general equilibrium to the model.

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Appendix 1. Welfare Cost Accounting in the Mexican Application

The fundamental resource requirement of an open economy is that imports must be paid for: trade must balance. (We abstract from planned international transfers and from adjustments in foreign exchange reserves, inessentially for present purposes.) This in turn means that the value of consumption expenditure less the value of gross domestic product (equal to all payments to domestic factors) must be equal to the net value of transfers to the consumer from the government (which can be positive or negative). Our task is to relate each of these components, the consumer expenditure, the gross domestic product, and the net government transfer, to underlying supply and demand structure. The tools we use are the representative consumer's expenditure function and the gross domestic product function. To treat a non-traded good with a consumer price ceiling (milled maize in the Mexican example), we modify the standard gross domestic product function to incorporate the requirement that the output of the targeted good must meet demand: the consumer must not be rationed. We also derive the gross domestic product function in a form in which it is easy to decompose the welfare analysis into partial and general equilibrium components. Our focus in the present application is on partial equilibrium.

Many agricultural products in our study are intermediate inputs. For example, sorghum is an input into livestock production. The evidence suggests that except for maize flour, the final goods stage of production and consumption is not distorted. Then for purposes of this study we may treat the sale of these products as final. Their price to users we treat as a 'consumer' price, which accords with common terminology in the agricultural economics literature. The user or consumer price vector is denoted q. The producer price vector is denoted p. The international price of these goods is p*. The consumer price of subsidized maize flour, a nontraded good, is denoted h, and the marginal cost of maize flour is denoted c. Agricultural production is subsidized in part through cheap fertilizer, with a user cost denoted f and an international price denoted f*. We assume that the marginal cost of production of fertilizer by the FERTIMEX state monopoly is equal to f*, which is an efficiency condition.

The policy instruments of the Mexican government are the price floors p, the consumer price ceilings q and h (for targeted groups) and the fertilizer price f. Finally, w is the vector of (nontraded) primary factor prices. The implicit subsidies and taxes are derived from the margins between domestic price targets and the external price for traded goods, and between consumer price and marginal cost for the nontraded goods.

Subsection I.1 develops the gross domestic product function. Subsection I.2 goes on to define the trade balance function and its policy derivatives. Subsection I.3 discusses the problem of the many consumer case briefly. This is relevant to the Mexican application, since the consumer subsidy policy is for targeted groups based on distributional concerns.

I.1 The Gross Domestic Product Function

The gross domestic product function is built up from the profit functions in each producing sector. We assume diminishing returns to scale, so that the profit function is defined. The diminishing returns assumption is based on sector-specific factors (it is widely used in computable general equilibrium analysis). The variable factors have a vector of prices denoted w. The profit functions give, for price-taking farmers, the maximum profit expressed as a function of the parametric prices of outputs and inputs. Let $\pi_i(p_i,f,w)$ denote the profit function in the agricultural producing sector i, while $\Pi(p,f,w)$ denotes the sum of the profit functions. The derivative of the each profit function with respect to its respective output price is equal to the output supply and the derivative with respect to the input prices is equal to minus the vector of input demands, by Hotelling's lemma. This means that

$$-\Pi_f = F,$$

where F is equal to the total demand for fertilizer. (Partial differentiation in the remainder of the paper is denoted by a subscript.)

For the non-traded final good subject to price distortion,[10] the subsidized (via subsidized inputs) firms must produce what the subsidized consumer demands, H at the fixed price h. The profits in the milled maize sector are equal to revenue hH minus the cost of production of the required amount. We assume that the firm is faced with the input price q_m for subsidized maize. The cost function (reflecting cost minimizing behavior with respect to whole maize and variable inputs) is thus $C(H,q_m,w)$. For the cost function in the nontraded good sector, the derivatives with respect to the input prices are equal to the vector of input demands, by Shephard's lemma, while C_H is the marginal cost.

Fertilizer is produced by the state monopoly FERTIMEX, which also imports fertilizer. We assume that its marginal cost of production is equated with the import price, which is efficient. This means that the output of FERTIMEX is equal to Y_F, which is the solution to:

$$C_Y(Y_F,w) = f^*.$$

FERTIMEX must import $F-Y_F$ at the price of f^* to cover demand. The profits or losses of FERTIMEX are equal to

$$fF - C(Y_F,w) - f^*(F-Y_F) = (f-f^*)F - \{C(Y_F,w) - f^*Y_F\}.$$

The second term is invariant to marginal changes in Y_F, due to the marginal efficiency condition. (Y_F is a function of w and f^*.) The first term is equal to the total fertilizer subsidy paid to farmers.

In partial equilibrium, the prices of primary factors are fixed. The gross domestic product is equal to the value of national payments to all factors (including specific factors). Let V denote the vector of primary factor supplies. Formally, the gross domestic product function is defined as:

$$\text{(A.1.1)} \qquad g(p,f,h,q_m,H;f^*,w,V) = w'V + \Pi(p,f,w) + hH - C(H,q_m,w) - (f-f^*)\Pi_f(p,f,w) - \{C(Y_F,w) - f^*Y_F\}.$$

In forming (A.1.1) we utilize the equality of the required fertilizer demand F with $-\Pi_f$. The second and third lines on the right hand side of (A.1.1) denote the subsidized milled maize and fertilizer sector profits respectively, while the first line on the right denotes the sum of payments to mobile factors plus the profits to the immobile factors in agriculture.

We will use partial equilibrium in this study. For perspective we should note the effect of going to general equilibrium. In this case, the gross domestic product function is defined as:

$$\text{(A.1.2)} \qquad G(p,f,h,q_m,H,f^*,V) = \min_{w} g(p,f,h,q_m,H;f^*,w,V).$$

The first order conditions for problem (A.1.2) imply that the vector of primary factor demands is equal to the vector of primary factor supplies, using Hotelling's and Shephard's lemmas. The solution values of w may be substituted into g() to obtain G(). Due to the minimum value property of G(), *the first derivatives of G with respect to p,f,q_m, and H are equal to the first derivatives of g with respect to p,f,q_m, and H.* Moreover, the relation of the second derivatives of G and the second derivatives of g is plain; the general equilibrium second derivatives with respect to p,f, q_m,H are equal to the partial equilibrium second derivatives with respect to p,f,q_m, H plus the partial equilibrium second cross derivatives with respect to w times the derivatives of w with respect to p,f,q_m, H. The latter link is being suppressed in partial equilibrium. This is probably a reasonable approach to our study, and it achieves a great simplification by reducing the information requirements for describing the supply side of the model.

Returning to partial equilibrium, we set out the first derivatives of g.

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[10]Milled maize is also produced for undistorted sale, with inputs purchased at the support price. No added distortion arises on this account, so it may be excluded from the calculations.

The derivative vector of g with respect to p is equal to:

$$\text{(A.1.3)} \quad g_p(.) = \Pi p(p,f,w) - (f-f^*)\Pi_{fp}$$

$$= Y(.) + (f-f^*)F_p(.)$$

Y(.) is the output vector. The vector F_p reveals for each sector the effect on demand for fertilizer of a rise in price from that sector. The derivative of g with respect to f is equal to:

$$\text{(A.1.4)} \quad g_f(.) = \Pi_f(.) - \Pi_f - (f-f^*)\Pi_{ff}$$

$$= (f-f^*)F_f.$$

The scalar F_f gives the effect of a rise in f on the aggregate demand for fertilizer.
The derivative of g with respect to q_m is equal to:

$$\text{(A.1.5)} \quad g_{qm} = -C_{qm}$$

$$= -M,$$

minus the demand for subsidized maize. Finally, the derivative vector of g with respect to H is:

$$\text{(A.1.6)} \quad g_H = h - c,$$

where c is the marginal cost vector $C_H(H,q_m,w)$.

I.2 The Trade Balance Function

The consumers expenditure function is equal to

$$\text{(A.1.7)} \quad e(q,h,u),$$

where u is a utility level. By Shephard's lemma, the derivatives of e with respect to q and h are equal to the quantities demanded,

$$e_q = X(q,h,u)$$

$$e_h = H(q,h,u).$$

The balance of trade requirement is

(A.1.8)

$$e(q,h,u) - g(p,f,h,H;f^*,w,V) = (q-p^*)'X(q,h,u) - (p-p^*)'Y(p,f,w) + (q_m - p^*_m)M(H,q_m,w),$$

where H must equal $e_h(q,h,u)$.

The left hand side of (A.1.8) is the excess of domestic expenditure over domestic factor payments. The right hand side of (A.1.8) is the net transfer from 'private agents' to or from the government treasury. The first term is minus the subsidy payment to consumers (with q less than p*). The second term is minus the subsidy payment to producers of final goods (with p greater than p*). The third term is minus the subsidy payment to subsidized producers of milled maize, where p^*_m is the international price of whole maize. (This is the relevant calculation, since maize is imported at the margin.) The interpretation of (A.1.8) is eased if we temporarily simplify to the case where q and p are equal and above p*, and $q_m = p^*_m$. Then (A.1.8) says that e - g, the net trade expenditure, must equal (p-p*)'(X-Y), the tariff revenue.

It is important to note that in this model, trade is 'residually' determined. For each distorted product, the supply price and the demand price are set by the government. To make the policy feasible, a level of imports must be set (otherwise consumers shift to the low cost import). But the quota follows residually from the domestic policies. Thus there is no quota distortion.

The trade balance function is formed by first substituting in (A.1.8) the demand function H(q,h,u) for H, and then subtracting the net transfer from the left hand side of the equation. :

$$\text{(A.1.9)} \quad B(q,p,h,f,u;.) = e(q,h,u) - g(p,f,h,H(q,h,u);f^*,w,V) - (q-p^*)'X(q,h,u) + (p-p^*)'Y(p,f,w) - (q_m - p^*_m)M(H(q,h,u),q_m,w).$$

The equilibrium level of welfare is the value of u which satisfies (A.1.9) at B equal to zero (i.e. satisfies the trade balance constraint (A.1.8)). The active argument list in B includes the domestic prices, q,p,h,f, which are policy instruments, and the level of u, which is determined in equilibrium. The dot denotes the arguments not utilized, f*,w,p* and V.

The trade balance function (A.1.9) forms the basis for the welfare cost accounting system. A reduction in the net foreign exchange required to support u is in principle extractable as a surplus, or compensating variation in income. For example, the welfare effect of a rise in one of the traded final goods prices under government control is $-\partial B/\partial q_j$.

The policy derivatives are, using (A.1.3)-(A.1.8):

$$-B_q' = (q-p^*)'X_q + (h-c)'H_q + (q_m-p^*_m)M_H H_q \quad \text{(A.1.10)}$$

$$-B_h' = (q-p^*)'X_h + (h-c)'H_h + (q_m-p^*_m)M_H H_h \quad \text{(A.1.11)}$$

$$-B_p' = -(p-p^*)'Y_p + (f-f^*)F_p' \quad \text{(A.1.12)}$$

$$-B_f = -(p-p^*)'Y_f + (f-f^*)F_f. \quad \text{(A.1.13)}$$

Our consumer demand data provided no evidence for cross effects in demand, so the system used in the results section sets X_h and H_q equal to zero.

In cases where the producer support price is raised with no offset to the intermediate user, as with the government firms and the non-subsidized private sector in Mexico, the welfare effect of a rise in p combines (A.1.10) and (A.1.12).

I.3 Several Consumer Groups

Mexican agricultural policy is driven in part by distributive justice concerns. See Levy and van Wijnbergen (1991) for an exploration. The representative consumer model is unable to capture these, and must assume that the distribution of individual utilities is maintained with the same type of lump sum mechanism used for the single consumer welfare analysis. From the point of view of the model above, expenditure means aggregate expenditure, and the different subsidies are on different goods in principle. Where knowledge of different elasticities for the same good by different consumers is available, this can be utilized in the formulae for $\partial B/\partial q_j$. In this type of approach, differential subsidies are inefficient, which may not be realistic under the constraints which in practice bind distributive policy.

Appendix 2: Data

1. Yearly Maize Data

Prices:

Year	domestic price p (pesos/ton)	International price p* (pesos/ton)	subsidized input price q (pesos/ton)
1985	52588	39696	27212
1986	94050	73497	44015
1987	233542	142920	131650
1988	390882	280262	224070
1989	437688	433433	280442

Sources: (1) and (2).

Quantities:

Year	M+Z Total Supply (tons)	M (a) Production (tons)	Z Imports (tons)	Non-subsid. Input use (tons)	Subsidized Input use (tons)
1985	11831397	9607900	2223497	9655597	2175800
1986	10066970	8363500	1703470	7495970	2571000
1987	10308890	6706000	3602890	7854390	2454500
1988	10921074	7618500	3302574	8656174	2264900
1989	11474512	7825800	3648712	9209512	2265000

Sources: (3) and (4).
(a) Includes domestic production less on-farm consumption estimated at 38 percent of the Spring Summer harvest.

2. Nontraded Maize Goods

Prices:

Year	nonsubsidy cons. price c (pesos/ton)	subsidized coupon price hc (pesos/ton)	subsidized urban price hs (pesos/ton)
1985	87714.00	16745.40	25516.80
1986	91701.00	22526.55	55618.65
1987	169048.75	25516.80	129178.80
1988	299025.00	25516.80	219285.00
1989	299025.00	25516.80	219285.00

Sources: (6).

Quantities:

Year	Yc coupon consumpt. (tons)	Ys urban consumpt. (tons)
1985	87700	2631000
1986	109980	2688688
1987	579810	2647668
1988	684470	2884764
1989	743000	2714500

Source: (6).

3. Yearly Sorghum Data

Prices:

Year	domestic price p (pesos/ton)	International price p* (pesos/ton)	subsidized input price q (pesos/ton)
	p	p*	d
1985	34160.00	31881.00	37768.00
1986	81790.00	62256.00	165704.00
1987	153242.00	127411.00	119684.00
1988	330618.00	275354.00	148335.00
1989	355893.00	315508.00	235954.00

Sources: (1) and (2).

Quantities:

Year	M+Z Total Supply (tons)	M Production (tons)	Z Imports (tons)	Non-subsid. Input use (tons)	Subsidized Input use (tons)
1985	8819420	6597000	2222420	5499493	3319927
1986	6676732	5895000	781732	5739853	936879
1987	7104870	6339000	765870	5516681	1588189
1988	7042288	5895000	1147288	4384174	2658114
1989	7470513	4806000	2664513	6252865	1217648

Sources: (3) and (4).

4. Wheat

Prices:

Year	domestic price p (pesos/ton)	International price p* (pesos/ton)	subsidized input price q (pesos/ton)
1985	37159.00	40156.00	18145.00
1986	62129.00	82988.00	74378.00
1987	139509.00	186132.00	129510.00
1988	313250.00	373468.00	194654.00
1989	389638.00	486444.00	486014.00

Sources: (1) and (2).

Quantities:

Year	M+Z Total Supply (tons)	M Production (tons)	Z Imports (tons)	Non-subsid. Input use (tons)	Subsidized Input use (tons)
1985	5533983	5214000	319983	4182612	1351371
1986	4994093	4770000	224093	3054417	1939676
1987	4843580	4409000	434580	3521934	1321646
1988	4856717	3665000	1191717	1587270	3269447
1989	4802261	4374000	428261	3289244	1513017

Sources: (3) and (4).

5. Soybean

Prices:

Year	domestic price p (pesos/ton)	International price p* (pesos/ton)	subsidized input price q (pesos/ton)
1985	93466.00	59251.00	62934.00
1986	184163.00	132212.00	120557.00
1987	503904.00	304429.00	420011.00
1988	842772.00	698704.00	632963.00
1989	1066960.00	680905.00	816395.00

Sources: (1) and (2).

Quantities:

Year	M+Z Total Supply (tons)	M Production (tons)	Z Imports (tons)	Non-subsid. Input use (tons)	Subsidized Input use (tons)
1985	2147909	929000	1218909	1655683	492226
1986	1535535	709000	826535	1441480	94055
1987	1892260	830000	1062260	1677700	214560
1988	1323587	226000	1097587	1246986	76601
1989	2102442	992000	1110442	2100051	2391

Sources: (3) and (4).

6. Dry Bean

Prices:

Year	domestic price p (pesos/ton)	International price p* (pesos/ton)	subsidized input price q (pesos/ton)
1985	156422.00	109721.00	126213.08
1986	270888.00	276317.00	187931.28
1987	490396.00	623024.00	389746.00
1988	974331.00	1031798.00	588489.00
1989	1276911.00	1144723.00	1083401.05

Sources: (2) and (7).

Quantities:

Year	M+Z Total Supply (tons)	M (a) Production (tons)	Z Imports (tons)	Non-subsid. Input use (tons)	Subsidized Input use (tons)
1985	828556	684000	144556	483930	344626
1986	992694	813750	178944	759625	233069
1987	801464	762000	39464	333038	468426
1988	683376	642750	40626	263601	419775
1989	547213	439500	107713	175498	371715

Sources: (3) and (4).
(a) Includes total production less 25 percent on-farm consumption.

7. Barley

Prices:

Year	domestic price p (pesos/ton)	international price p* (pesos/ton)
1985	52496	48627
1986	77684	103569
1987	148782	169665
1988	381227	307852
1989	492680	454775

Source: (8).

Quantities:

Year	M+Z Total Supply (tons)	M Production (tons)	Z Imports (tons)
1985	574219	536,000	38,219
1986	518781	515,000	3,781
1987	617548	617,000	548
1988	357539	350,000	7,539
1989	558027	433,000	125,027

Sources: (3) and (4).

8. Cottonseed

Prices:

Year	domestic price p (pesos/ton)	International price p* (pesos/ton)
1985	51785	54480
1986	56616	112357
1987	88400	350530
1988	368154	561645
1989	783960	848291

Sources: (9)

Quantities:

Year	M + Z Total Supply (tons)	M Production (tons)	Z Imports (tons)
1985	381702	317,000	64,702
1986	239767	226,000	13,767
1987	434327	414,000	20,327
1988	543545	491,000	52,545
1989	319579	255,000	64,579

Sources: (3) and (4).

9. Sunflowerseed

Prices:

Year	domestic price p (pesos/ton)	International price p* (pesos/ton)
1985	104695	77870
1986	181816	136583
1987	310893	306855
1988	677407	674467
1989	787555	721713

Sources: (10).

Quantities:

Year	M+Z Total Supply (tons)	M (1) Production (tons)	Z Imports (tons)
1985	590000	20000	570000
1986	473410	6000	467410
1987	226013	8000	218013
1988	187000	12000	175000
1989	110343	10000	100343

Sources: (11).

10. Sesameseed

Prices:

Year	domestic price p (pesos/ton)	International price p* (pesos/ton)
1985	155130	145195
1986	301224	295031
1987	891382	738977
1988	1214526	1174196
1989	1919231	1280064

Sources: (10).

Quantities:

Year	M+Z Total Supply (tons)	M (1) Production (tons)	Z Imports (tons)
1985	75000	75,000	14,342
1986	59000	59,000	33,542
1987	52000	52,000	10,494
1988	34000	34,000	4,427
1989	31000	31,000	0

Source: (11).

11. Coffee

Prices:

Year	domestic price p (pesos/ton)	International price p* (pesos/ton)
1985	684953	824610
1986	1764447	2597687
1987	2867823	3383477
1988	1938196	6702459
1989	2072936	4939703

Sources: (12).

Quantities:

Year	M-X Dom. Supply (tons)	M Production (tons)	X Exports (tons)	INMECAFE Marketed (30 percent)
1985	82708	260,000	177,292	78000
1986	177678	375,000	197,322	112500
1987	365748	578,000	212,252	173400
1988	297123	423,000	125,877	126900
1989	290984	469,000	178,016	140700

Sources: (11).

12. Fertilizer

Prices:

	Mexico	U.S.A.
1985	58299	189185
1986	105121	327053
1987	240630	666792
1988	488692	1192938
1989e	607710	1342215

Sources: (13)

Quantity:

Quantity Consumed (tons) Nitrogenous	Phosphate
1262600	382800
1324900	410000
1345000	433700
1269600	394900
1269600	394900

Sources: (13).

Fertilizer Cost Shares:

	Fertilizer cost share in total production costs P-V 1985	O-I 1985-86	Weighted Average
Maize	0.095	0.113	0.096
Dry Beans	0.048	0.052	0.049
Sorghum	0.15	0.133	0.144
Soy Bean	0.06	0.063	0.060
Wheat	0.084	0.082	0.082
Weighted Average	0.104	0.099	0.10272577

P-V is the Spring-Summer planting cycle.
O-I is the Fall-Winter planting cycle.
Source: (14).

Data Sources:

(1) Secretaría de Agricultura y Recursos Hidraulicos, Dirección General de Estudios del Sector Agropecuario y Forestal (DGESAF). p is the farmgate price, p* the international C.I.F. price including border and handling costs.

(2) q is the average price charged by Conasupo. Source is the Economic Research Service, USDA.

(3) Secretaría de Agricultura y Recursos Hidraulicos, Subsecretaría de Planeación, (1990), Boletín Mensual de Información Básica del Sector Agropecuario y Forestal (Avance del mes de noviembre), Mexico D.F. December.

(4) Instituto Nacional de Estadística, Geografía e Informática, (various issues), Boletín de Información Oportuna del Sector Alimentario, Aguascalientes, Ags.

(5) p and p* are aggregated from monthly Conasupo data using production and import volume weights respectively. Conasupo data includes: for p, the guarantee price plus transport, handling, and insurance costs; for p*, international C.I.F. price plus border and handling costs.

(6) Instituto Nacional de Estadística, Geografía e Informática, (1988) Abasto y Comercialización de Productos Básicos: Maiz, Aguascalientes, Ags. and Conasupo Data.

(7) Dry Bean farmgate prices are from ERS-USDA. Subsidized sale price for 1987 and 1988 is from Conasupo data. 1985, and 1988-89 are estimated using the wholesale price index for dry beans in Mexico City in (4).

(8) Barley farmgate prices from ERS-USDA. International Prices from 1990 CRB Commodity Year Book , adjusted for C.I.F. and border and handling costs.

(9) Farmgate prices from ERS-USDA. International Prices were taken from the unit value of imports (Banco de México, Indicadores del Sector Externo), and adjusted for C.I.F. and border and handling costs according to data in Instituto Nacional de Estadística, Geografía e Informática, (1988) Abasto y Comercialización de Productos Básicos: Oleaginosas, Aguascalientes, Ags.

(10) Farmgate prices from ERS-USDA. International Prices from Oil World Week ; C.I.F. Rotterdam, and adjusted for border and handling costs according to data in Instituto Nacional de Estadística, Geografía e Informática, (1988) Abasto y Comercialización de Productos Básicos: Oleaginosas, Aguascalientes, Ags.

(11) World Bank database.

(12) Farmgate prices from World Bank database. International price of coffee from Complete Coffee Coverage, International Coffee Organization, Other Mild Arabica, average New York and European markets.

(13) Fertilizer prices are consumption weighted averages of Nitrogen, Phosphate, and Potash fertilizer prices in each country. Mexican Fertilizer prices for 1989 are estimated using price index for fertilizer from (4). Source: FAO Fertilizer Yearbook, Vol 39, 1989. United Nations Food and Agriculture Organization, Rome, 1990.

(14) Individual crop cost shares were taken from preliminary data of the national survey on costs, technical coefficients, and yields in Mexican agricultural production, (Encuesta Nacional de Costs, Coeficientes Técnicos, y Rendimientos de la Producción Agrícola; SARH, 1985).

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