Journal of International Economics 52 (2000) 235–257
www.elsevier.nl/locate/econbase

A unification of second best results in international trade

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Received 3 August 1998; accepted 19 July 1999

Abstract

The received wisdom from the theory of second best is that the presence of distortions in some sectors of the economy would in general require intervention in other sectors as well. This paper offers a simple set of propositions which help unify the results of numerous papers in the international trade literature involving the theory of second best, many of which appear to contradict this theory. The propositions identify how, in optimization problems in economics, pre-imposed quantitative restrictions enter differently from price restrictions. The implications of this difference for the conduct of second-best optimum policies are also analyzed. In particular, the paper identifies and discusses the conditions under which the presence of distortions in some sectors does not undermine the case for non-intervention in other markets. © 2000 Elsevier Science B.V. All rights reserved.

Keywords: Theory of second best; Welfare; Commercial policy; Trade policy; Taxation; Piecemeal reform

JEL classification: F11; F13; H20; D50

1. Introduction

Stimulated by the pioneering contribution by Bhagwati and Ramaswami (1963), an extraordinarily large body of literature has developed on optimal policies in the

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PII: S0022-1996(99)00057-4

presence of distortions in one or more sectors of the economy.[1] The received wisdom from this theory, as stated in the original contribution by Lipsey and Lancaster (1956), is that in the presence of distortions in one or more sectors, welfare can be improved by intervening appropriately in other sectors of the economy. Papers dealing with specific second-best problems generally attempt to identify such interventions.

In this paper, we unify the results of numerous papers on the theory of the second best by proving a set of propositions with reference to a generic optimization problem, as in Lipsey and Lancaster (1956), and then applying these propositions to several specific second-best problems in the pure theory of international trade.[2] We show that many results relating to the global optimality of free trade, piecemeal trade reform, customs unions theory, the principle of targeting, immiserizing growth, the theory of non-economic objectives, and the welfare effects of aid and directly unproductive profit seeking (DUP) activities in the presence of distortions are specific applications of these propositions.[3] Our basic propositions are, however, general enough that they can be readily applied to second-best problems in other branches of microeconomics, especially public economics.

The key steps in our unification of the literature are to show how, in optimization problems, quantitative restraints enter differently from price restraints, to derive the implications of this difference for the conduct of policy in

[1] As Panagariya (1999) carefully documents, though Meade (1955b) had discussed many second-best problems in his now celebrated *Trade and Welfare*, it was not until the forceful statement and clear demonstration, by Bhagwati and Ramaswami (1963), of the targeting principle and the superiority of free trade over intervention, once the distortion had been neutralized, that the literature on domestic distortions and commercial policy actually took off.

[2] We restrict attention to traditional second-best problems a la Bhagwati and Ramaswami (1963) and Bhagwati (1971) and do not consider the more recent literature on second best problems based on imperfect competition, imperfect information or incomplete markets.

[3] In addition to the well-known analyses of Bhagwati and Ramaswami (1963) and Johnson (1965) on domestic interventions, Bhagwati and Srinivasan (1969) on non-economic objectives, Bhagwati (1971) on general theory of distortions and Kemp and Wan (1976) on welfare improving customs unions, a short list of the relevant papers in international trade theory includes Bertrand and Vanek (1971), Lloyd (1974), Hatta (1977), Corden and Falvey (1985), Falvey (1988) and Fukushima and Hatta (1979), and Anderson and Neary (1992) on piecemeal policy reform, Wooton (1988) and Brecher and Diaz Alejandro (1977) on the implications of capital mobility in the presence of distortions, Bhagwati et al. (1983), Brecher and Bhagwati (1982) and Lahiri and Raimondos (1995) on the welfare effects of income transfers, Bhagwati (1958), Krishna and Bhagwati (1997) on welfare improving customs unions in the presence of domestic distortions or non-economic objectives, Johnson (1967) and Eaton and Panagariya (1982) on immiserizing growth, and Bhagwati and Srinivasan (1982) on DUP activities in the presence of distortions. Dixit and Norman (1980), Woodland (1982), Bhagwati et al. (1998) and Vousden (1990) provide textbook treatments of many second-best issues in trade theory while Dixit (1985) offers a detailed treatment of related public-finance questions in an open-economy setting. Finally, Srinivasan (1996) integrates many recent developments on second best into the generalized theory of distortions.

second best environments and, most importantly, to link these implications to results in the literature. To be sure, some previous papers in the literature do recognize the difference between price and quantity restraints in deriving their results (e.g., see Alam, 1981; Bhagwati and Srinivasan, 1982; Anam, 1985; Neary, 1988), but they all do so within quite specific contexts. And *none* recognizes the principle underlying this difference, the generality that we identify and elaborate on, or the ubiquity of this as a driving mechanism behind so many results in the international trade literature. As we explain in Section 2, a separate literature in the area of public finance, focusing on the implications of certain 'separability' properties of the objective function and constraints, has some bearing on what we do in this paper. However, since this literature does not examine the issue of price vs. quantity distortions, it has played virtually no role in the development of the vast second-best literature which focuses, particularly in international trade, on the conduct of policy in the presence of these two types of distortions.

In Section 2, we look at the implications for optimality conditions when a subset of sectors is subject to either price or quantity distortions. The central question we ask here is, in optimization problems, what distinguishes price distortions from quantity distortions? Why is it that the two sets of distortions have dramatically different implications for second-best intervention policies? The key result we identify is that, having stated the first-best problem, if the additional constraints defining the second-best problem are such that they directly restrict the choice of a subset of variables, optimality requires that the first-order conditions with respect to the remaining variables obtained in the first-best problem not be violated. On the other hand, if the additional constraints restrict the first-order conditions obtained in the first-best problem, in general, all first-order conditions of the first-best problem must be violated. This apparently straightforward result turns out to underlie a large number of important results in the theory of second-best. For example, in a multi-country world, if the level of pollution in different countries is fixed quantitatively, as is generally the case, even if that level happens to be suboptimal, free trade remains globally optimal. Similarly, if a small, open economy chooses a fixed level of pollution through a quantity instrument such as pollution permits, free trade remains a welfare maximizing policy at the national level.[4]

In Section 3, we consider problems of comparative statics when a subset of sectors is subject to one of these types of distortions. Here we show that if a subset of first-order conditions of a first-best maximization problem is replaced by direct

[4]As we will see later, a sharp distinction must be drawn between results obtained under the assumption that quota rents are fully utilized and those obtained when these rents are partially or wholly destroyed. The results just stated in the text require that rents associated with pollution permits are fully utilized. The distinction has important implications for the results obtained in the presence of import quotas and voluntary export restraints. In the latter case, rents are partially or wholly transferred to the exporting country.

restrictions on the associated choice variables while other first-order conditions continue to be satisfied, changes in parameters that increase the value of the objective function in the first-best setting continue to do so in this second-best setting. For example, in the well-known Bhagwati (1958) example of immiserizing growth in an economy with monopoly power in international trade, it is not necessary to impose the optimum tariff to avoid a reduction in welfare following growth. Instead, it is sufficient to subject imports to an arbitrary quota (Alam, 1981).

In Section 4, we turn to a discussion of welfare-improving, piecemeal reductions in the two types of distortions when they exist in isolation and simultaneously. In each case, we show how the results from the existing literature fit into our general framework. For example, as Wooton (1988) has shown, if a customs union sets its common external tariffs optimally, relaxing internal factor mobility raises joint (member country) welfare necessarily. Section 5 concludes the paper.

2. Optimality conditions: price versus quantity distortions

All second-best problems must, by definition, be stated in relation to a first-best problem. Once the first-best problem is specified, a second-best problem obtains when one or more binding constraints are added to it. The key to explaining the difference between second-best problems involving quantitative distortions and those involving price distortions is to recognize that the former constrain directly a subset of choice variables while the latter restrict a subset of first-order conditions of the original, first-best problem. We begin by proving:

Proposition 1. *Suppose we solve a constrained optimization problem and obtain the first-order conditions associated with it. If we now impose the additional restriction*(*s*) *that one or more of these first-order conditions be violated, reoptimization will, in general, involve violation of the remaining first-order conditions as well* (*Lipsey and Lancaster*, 1956). *If, instead, we restrict the level of a subset of choice variables directly or through a set of convex constraint sets not exceeding the number of restricted variables and then reoptimize, the first-order conditions with respect to the remaining choice variables will be identical to those obtained in the first-best problem.*

Observe that, as noted, the first half of this proposition goes back to Lipsey and Lancaster (1956) and is indeed the basis of the frequent assertion that whenever we are in the second-best world, welfare can be improved by intervening appropriately in other sectors. Our objective in restating this result in the present context is to contrast it with the second part of the proposition where, despite being in the second-best world, it does not pay to distort the system further.

In proving Proposition 1 and our subsequent results, we rely primarily on a first-best maximization problem with a single constraint and assume that the choice variables entering the objective function and the constraint set are the same. Generalizations to cases involving multiple constraints or variables which enter only the objective function or constraint set are straightforward and occasionally offered in the context of specific problems.

Throughout the paper, we use lower-case letters with subscripts to denote variables, lower-case bold-face letters (sometimes with subscripts) to denote vectors, upper case bold-face letters to denote sets, and standard upper-case letters to denote functions. Elements in a set are indexed by the lower-case letter corresponding to the upper-case letter denoting the set. Letting $\mathbf{x} = (x_0, x_1, x_2, \ldots, x_n)$ be the $(n+1)$-dimensional vector of choice variables and s a scalar, we can represent the objective function by $F(\mathbf{x})$ and the constraint set by $G(\mathbf{x}) \leq s$. $F(\mathbf{x})$ is increasing and concave and $G(\mathbf{x})$ increasing and convex in $\mathbf{x}$. The latter property ensures that the constraint set, $G(\mathbf{x}) \leq s$ is convex. The objective function $F(\mathbf{x})$ can naturally be interpreted as the utility function and the constraint $G(\mathbf{x}) \leq s$ as the production possibilities set. Thus, our problem is similar to that of maximizing a representative consumer's utility subject to the production possibilities set in a closed economy.[5] The Lagrangian associated with this problem, which we will henceforth call the original or first-best problem, can be written as,[6]

$$\max_{x_i, \lambda} \Omega = F(x_0, x_1, \ldots, x_n) + \lambda[s - G(x_0, x_1, \ldots, x_n)]. \tag{1}$$

We index the elements of $\mathbf{x}$ by subscript i and denote the set of all i by $\mathbf{I}$. Choice variable 0 serves as the numeraire. The numeraire and the first-order condition associated with it in the first-best problem (1) are not subject to any restriction throughout the paper. In every case, we assume that an interior solution exists and focus exclusively on that solution. Denoting by F_i and G_i the first partials of $F(.)$ and $G(.)$ with respect to x_i, the first-order conditions associated with (1) can be written as,

$$F_i = \lambda G_i, \quad i = 0, 1, 2, \ldots, n \quad \text{or } i \in \mathbf{I} \tag{2}$$

$$G(\mathbf{x}) = s. \tag{3}$$

[5] The use of such Samuelsonian social welfare functions is, of course, wholly common in the international trade literature. See Dixit (1985) for an articulate exposition of the structure underlying the use of such a representation.

[6] It should be recognized that in this maximization problem (1), as in the other maximization problems stated in this paper, the control variables are chosen to maximize the Lagrangian and Lagrange multipliers are chosen to minimize it.

These are $n+2$ equations that can be solved for $n+1$ x_is and λ. We can reduce the system to $n+1$ equations in $n+1$ variables by eliminating λ from (2). Thus, dividing the first-order condition for choice variable i ($i=1,\dots,n$) by that for variable 0, we have

$$\frac{F_i}{F_0}=\frac{G_i}{G_0}, \quad i \in \mathbf{I}. \tag{2'}$$

This is a familiar condition in economics: in a closed economy, the marginal rate of substitution between every pair of commodities should be equated to the marginal rate of transformation between the same pair of commodities. In a market setting, prices perform the function of relating appropriately the marginal rate of substitution to the marginal rate of transformation. When the price of product i in terms of the numeraire good facing the consumer is the same as that facing the producer, the two marginal rates are equalized. The conventional form of a price distortion in a closed economy is an ad valorem or per-unit tax on either the producers or the consumer. We consider an ad valorem tax on the consumer. Thus, assume that the consumption of a subset of goods denoted $\mathbf{J}$ and indexed by j is subject to the ad valorem tax t_j. Taking these taxes as given, what conditions maximize $F(\mathbf{x})$ subject to $G(\mathbf{x}) \leq s$? As already noted, this was the problem posed by Lipsey and Lancaster (1956) in their seminal contribution. With restrictions stated in terms of prices, optimality conditions of the original, first-best problem must be violated in such a way as to keep the marginal rate of substitution between j and the numeraire good 0 above the marginal rate of transformation between the same pair of goods by factor $1+t_j$. Formally stated, the problem now takes the form:

$$\max_{x_i,\lambda,\mu_j} \Delta = F(x_0,x_1,\dots,x_n)+\lambda(s-G(x_0,x_1,\dots,x_n)) + \sum_{j\in\mathbf{J}} \mu_j\left[\frac{F_j}{F_0}-(1+t_j)\frac{G_j}{G_0}\right], \quad i\in\mathbf{I},\ j\in\mathbf{J}. \tag{4}$$

Since the partial derivatives in the square brackets of (4) are functions of all x_is, each first-order condition with respect to the x_i will include extra terms related to these derivatives. The optimality condition (2′) of the first-best problem, requiring the equality of the marginal rate of substitution and the marginal rate of transformation, must be now violated for all pairs of goods. *Stated differently, if distortions in sectors j cannot be removed, it will generally pay to distort all other sectors as well*. This influential Lipsey and Lancaster (1956) result is the source of the general impression in the literature on second-best that when one or more sectors are distorted, welfare can be improved by intervening appropriately in other sectors.[7]

Note that the Lipsey–Lancaster result is stated with respect to a very specific distortion. As such, it stands to reason that there may be other forms of distortions, defined generically as restrictions which rule out the attainment of the first-best solution, that do not lead to such a strong conclusion. Quantitative restrictions, which restrict the choice variables directly rather than the first-order conditions of the first-best problem, are examples of such distortions.

Thus, assume now that the distortion takes the form of a set of restrictions that depend on a subset of choice variables. Distinguish the subset of these variables by subscript k and denote the set of all k by $\mathbf{K}$ and the vector of all x_k by $\mathbf{x_k}$. In all, we can introduce as many independent restrictions as the number of x_k. Denote the restrictions by $N_k(\mathbf{x_k}) \leq \bar{x}_k$ and assume that they are all convex. A direct restriction on a choice variable can be obtained by setting $N_k(\mathbf{x_k}) = \bar{x}_k$. Another special case of interest arises when $N_k(\mathbf{x_k})$ is linear. The Lagrangian associated with this problem can be written as,

$$\max_{x_i, \lambda, \pi_k} \Gamma = F(x_0, x_1, \ldots, x_n) + \lambda(s - G(x_0, x_1, \ldots, x_n)) + \sum_{k \in \mathbf{K}} \pi_k(\bar{x}_k - N_k(\mathbf{x_k})), \quad i \in \mathbf{I}, k \in \mathbf{K}. \tag{5}$$

The first-order conditions of this second-best problem are given by

$$F_i = \lambda G_i \quad i \notin \mathbf{K} \tag{6a}$$

$$G(\mathbf{x}) = s \tag{6b}$$

$$F_h = \lambda G_h + \sum_{k \in \mathbf{K}} \pi_k\, (\partial N_k / \partial x_h) \quad h \in \mathbf{K} \tag{7a}$$

$$N_k(\mathbf{x_k}) = \bar{x}_k \quad k \in \mathbf{K}. \tag{7b}$$

Comparing (6a) with (2), it is immediately obvious that the first-order

[7] An important qualification to this result, noted by Davis and Whinston (1965), is that if the functions F and G are each separable between variables in $\mathbf{J}$ and those not in $\mathbf{J}$, then the additional constraints introduced in (4) fail to yield the case for intervention in the other sectors. However, most interesting second-best problems do not impose, a priori, this kind of separability on the objective function or its constraints. Short of this a priori imposition, this separability is unlikely to obtain except by sheer coincidence. Not surprisingly, as Pettengill (1974) points out, the results of the Davis–Whinston analysis do not apply to a wide range of economic problems. Subsequent developments in this 'separability' literature, as ably discussed in Boadway and Harris (1977) and Jewitt (1981), have focused on identifying even weaker conditions than the additive separability assumed by Davis and Whinston. As noted earlier in the introductory section, this literature fails to bring out the implications of the differences between price and quantity distortions. Indeed, the challenge lies in identifying policy constraints that are consistent with separability and those that are not. Our paper does precisely this, by focusing on price vs. quantity distortions.

conditions associated with variables not subject to *additional* constraints are the same as in the first-best problem. For $i \not\in \mathbf{K}$, we continue to equate the marginal rate of substitution between good i and the numeraire good to the marginal rate of transformation between the same pair of goods. The intuitive reason behind this result is straightforward. After we have optimally chosen the subset of variables subject to the new restrictions, we can think of the remaining problem as the original problem defined on variables not included in **K**. It is as though we take out the resources necessary to produce efficiently the quantities of restricted variables and then maximize the objective function over unrestricted variables subject to the new resource constraint.

In a market setting, for goods $i \not\in \mathbf{K}$, prices facing producers and consumers must be the same. For products $k \in \mathbf{K}$, which are subject to additional constraints, the consumer will have to be subject to prices different from those faced by the producer. In particular, letting good 0 be the numeraire, the condition for $h \in \mathbf{K}$ in (7a) can be combined with that for good 0 in (6a) to yield:

$$\frac{F_h}{F_0} = \frac{G_h}{G_0} + \frac{\sum_{k \in \mathbf{K}} \pi_k (\partial N_k / \partial x_h)}{\lambda G_0}, \quad h \in \mathbf{K}. \tag{8}$$

To create the right divergence between the two sets of prices, the consumer can be subject to a per-unit tax measured by the last term in (8) with tax proceeds redistributed in a lump-sum fashion.[8]

The key implication of the second half of Proposition 1 is that if the unalterable distortions take the form of restrictions on a subset of choice variables, normally quantities in economic problems, the objective function is maximized by satisfying the first-order conditions of the first-best problem in the remaining sectors along with other first-order conditions. In the context of economic problems, this means that if unalterable distortions apply exclusively to quantities, welfare maximization requires that no additional distortions be introduced anywhere else in the economy. This result is at the heart of many results in economics, especially trade theory.

Before we discuss some of these results, however, we make two further points: (i) in applying the second half of Proposition 1 to a market setting, we must assume that all rents generated by restrictions on the choice variables are redistributed to the consumer in a lump-sum fashion;[9] and (ii) the distinction we

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[8]From (6a), λ is positive. We will show later that if the binding restriction on good k takes the form $x_k \le \bar{x}_k$, then π_k is also positive. Therefore, the price facing the consumer must exceed that facing the producer.

[9]This is an important restriction since, as a practical matter, rents are often partially shared, as for instance, with voluntary export restraints. This type of asymmetry in the implications of import quotas with and without rent destruction was recognized by Anam (1986), discussed in greater detail by Neary (1988) and developed further by Anderson and Neary (1992) in the context of specific second-best problems. Having noted this important qualification, we should state that for the rest of the paper, we will maintain throughout the assumption of zero rent destruction.

have made between *prices versus quantity distortions* and constraints on *choice variables versus first-order conditions* is a substantive one.

To see the latter point, consider an optimization problem in which prices are the choice variables: the problem of a government in a closed economy which wishes to maximize tax revenue raised through indirect taxes.[10] To make the point most simply, assume that production in the economy is Ricardian and that labor, supplied in fixed quantity, L, is the only factor of production.[11] The production surface is linear in this case and relative producer prices are fixed. Let $\boldsymbol{p} = (p_0, p_1, \ldots, p_n)$ denote the producer–price vector and $\boldsymbol{t} = (t_0, t_1, \ldots, t_n)$ the associated vector of per-unit tax rates. Then, assuming good 0 to be the numeraire, which is not subject to a tax, we have $p_0 = 1$ and $t_0 = 0$. We can represent the economy's demand side by the standard expenditure function $E(1, p_1 + t_1, \ldots, p_n + t_n; u)$, where u denotes utility. $E(.)$ is concave and linear homogeneous in all prices. Choosing units of good 0 such that one unit of labor translates into one unit of the good, the wage equals unity and wage income L. We can write the government's tax-revenue maximization problem as:

$$\max_{\boldsymbol{t},u} \boldsymbol{t}E_p(\boldsymbol{p} + \boldsymbol{t}, u) \quad \text{s.t.} \quad E(.) \le L + \sum t_i E_i(.), \tag{9}$$

where $E_i(.)$ denotes the partial derivative of $E(.)$ with respect to the ith price. As is usual, it is assumed that tax revenue is rebated back to the consumer. It is easily verified that the first order conditions of this problem remain unchanged if some of the taxes are initially fixed at arbitrary levels. That is, if $t_1 = \bar{t}_1$ to begin with, the form of the first order conditions corresponding to the remaining tax rates remains unchanged. This underscores our point that it is the difference between constraining choice variables and first-order conditions rather then the difference between constraining quantities and prices that is relevant.[12]

We are now ready to enumerate the results that follow from Proposition 1. First, consider the case of externalities. If a variable generates externalities, markets fail to generate its quantities optimally. Then, in the spirit of the first half of Proposition 1, a case exists for intervention in the choice of other variables. If the value of the variable generating the externality is itself fixed exogenously, however, the case for intervention elsewhere vanishes. As a concrete example, take environmental pollution. Assume that x_l in our optimization problem represents pollution. Think of $F(.)$ as the utility function and $G(.) \le s$ as the production

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[10] This is the well-known problem analyzed by Ramsey (1927) and Boiteux (1956).

[11] We are grateful to an anonymous referee for suggesting this production structure to further simplify the example.

[12] Having emphasized here that the result stated in Proposition 1 distinguishes between restrictions on choice variables and restrictions on first-order conditions (rather than between quantity distortions and price distortions), we should note that in the majority of the applications in economics, the former imply quantity distortions and the latter imply price distortions. Indeed, this is the case in the analysis and examples presented in the rest of this paper. Thus, we use these terms interchangeably.

possibilities set, with F_l, $G_l < 0$. The optimality condition for l in the first-best problem, $F_l/F_0 = G_l/G_0$ says that, at the margin, we must equate the amount of good 0 the consumer is willing to accept for tolerating an extra unit of pollution to the amount of good 0 saved in costs when an extra unit of pollution is used in production. If the pollution charge is set at a level different from $-G_l/G_0$, the case opens up for interventions in other sectors. But if pollution regulation takes the form of quantity control, as is often true in practice, no case for other interventions exists. This result has profound implications for the ongoing debate on trade and the environment. While it has been argued that due to a sub-optimal choice of pollution levels, free trade is not globally optimal, if countries fix pollution levels quantitatively rather than through price instruments, under the usual conditions, free trade remains globally optimal.

Second, take the gains from trade theorem itself as it relates to global welfare (Samuelson, 1962; Grandmont and McFadden, 1972). According to this theorem, under perfect competition, in a multi-good, multi-country multi-factor world with no international factor mobility (regardless of whether technologies are similar or different) and assuming that global welfare can be represented by a standard social welfare function (Samuelson, 1956), free trade in goods maximizes world welfare. Contrary to its appearance, in general, this proposition is not a first-best proposition. In the presence of international differences in technology, full production efficiency cannot be achieved without international mobility of factors of production. Therefore, under the assumption of no international factor mobility, we are in the second-best world. Yet, the gains-from-trade theorem works because the restrictions on factor mobility are direct restrictions on choice variables.[13] By contrast, if we were to restrict factor mobility by price interventions such as a tax, free trade in goods will fail to maximize global welfare.

Third, one of the key controversies in the 1940s related to whether perfect inter-sectoral mobility was necessary to establish the case for free trade in a small, open economy. Haberler (1950) eventually settled the controversy by demonstrating that the gains from trade were assured even if factors were perfectly immobile across sectors. He went on to demonstrate that if, instead, factor prices were rigid, it was possible for protection to yield a better outcome than free trade. It should be evident that this result readily fits into our Proposition 1.

Fourthly and more subtly, take the important result, due to Dixit and Norman (1980), on the gains from trade in the absence of lump-sum transfers. According to this result, free trade is superior to autarky in the sense that there exist indirect taxes and subsidies which leave each consumer as well off under free trade as under autarky and yield a positive tax revenue. Indeed, in the small-country case, a *stronger* result can be proved. The Dixit–Norman result is that free trade is superior to autarky. Dixit (1985), shows that, as in the presence of lump-sum

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[13] We could, in addition, impose quantitative restrictions on trade in a subset of goods. Free trade in the remaining goods will still be welfare maximizing, given these restrictions.

transfers, free trade *maximizes* the gains from trade in a small, open economy. Both results rely on effectively freezing the consumption vectors of consumers at the pre-trade level (i.e. establishing appropriate quantitative restrictions) and then not interfering with first-order conditions (prices) in the rest of the system. The link with our Proposition 1 should be clear.[14]

Finally, in their original expositions of the targeting principle in the presence of non-economic objectives, Corden (1957), Johnson (1964, 1965) and Bhagwati and Srinivasan (1969) had demonstrated that if a small open economy wants to restrict or encourage the output, consumption or imports of a subset of goods to a particular level, it should 'target' those variables directly and refrain from intervening elsewhere in the economy. Once again, the mechanism is the same: in the first-best world, welfare maximization requires free trade and no domestic interventions; if a subset of choice variables are then restricted directly, there is no case for interventions elsewhere. An interesting application of this targeting principle is Corden and Falvey's (1985) conclusion that if import quotas are the only interventions and cannot be removed, optimality dictates that no new interventions be introduced.

Proposition 1 is easily extended to incorporate and generalize this theory of non-economic objectives and the targeting principle. If the problem is to maximize welfare in the presence of an exogenously-specified general target, for example, a weighted sum of outputs of a subset of sectors, we should restrict a subset of choice variables collectively rather than individually so as to satisfy the exogenous target. The key question is whether it pays to 'distort' sectors other than those over which the objective is defined? The answer from the existing literature on international trade seems to be in the negative. It is easy to show, however, that this answer is the outcome of the specific structure of the non-economic objectives considered in that literature. The general answer is that if the non-economic objective is defined in such a way that it restricts only the choice variables, sectors not covered by it should not be distorted. However, the objective, if it is defined such that it requires violation of one or more first-order conditions of the first-best problem, then all sectors should be distorted.

Thus, in the context of our model, consider the natural non-economic objective of restricting a weighted sum of a subset of the x_i. Formally, suppose we require $\Sigma_k\ a_k x_k \leq b$ where b and a_k are constants. The relevant Lagrangian now is,

$$\max_{x_i,\lambda,\mu} \chi = F(x_0, x_1, \ldots, x_n) + \lambda(s - G(x_0, x_1, \ldots, x_n)) + \pi(b - \sum_{k \in \mathbf{K}} a_k x_k), \quad i \in \mathbf{I}. \tag{10}$$

The first-order conditions are

[14] Space constraints prevent a greater elaboration of this point here. However, the interested reader is referred to Krishna and Panagariya (2000).

$$F_i = \lambda G_i \quad i \not\in \mathbf{K} \tag{11a}$$

$$F_k = \lambda G_k + \pi a_k \quad k \in \mathbf{K}. \tag{11b}$$

Because weights a_k are constant, it does not pay to distort activities other than k. In the applications in the international trade literature (Johnson, 1964; Bhagwati and Srinivasan, 1969), the context is usually that of a small country and the weights in the non-economic objective are world prices. Because these prices are fixed via the small-country assumption, the optimal prescription turns out to be direct intervention only in sectors subject to the restriction. But, in general, the weights themselves can be related to the first-order conditions of the first-best problem. For example, in the present context, they can be chosen to equal domestic producer prices. We then have $a_k = G_k/G_0$ and it becomes necessary to violate the first-order conditions of the first-best problem for all variables.[15]

To explain a different set of results in the literature relating to welfare improvement when price and quantity distortions co-exist and the former are removed but not the latter, it is useful to state a straightforward corollary to Proposition 1.

Corollary 1. *Suppose, in the initial equilibrium, one or more first-order conditions of a first-best problem are violated and one or more choice variables are restricted through a set of independent convex constraint sets not exceeding the number of restricted variables. If we now restore all first-order conditions which had been initially violated but leave a subset of constraints on the variables in place, the value of the objective function cannot fall.*

The proof of this corollary is trivial from the last part of Proposition 1. If a subset of variables of a first-best problem is restricted by a set of convex constraint sets, the value of the objective function is *maximized* by satisfying the first-order conditions of the first-best problem with respect to all other variables. Therefore, if the initial equilibrium is characterized by a violation of the first-order conditions of the first-best problem with respect to one or more of these other variables, restoring them will increase the value of the objective function.

This seemingly obvious corollary can help connect some important but sophisticated results in the literature to Proposition 1. Thus, consider first the

[15] In an open-economy context, then, consider an initial (first-best) equilibrium in which a large country has its optimal tariff vector in place. Now consider the introduction of a protection objective requiring that the value of output of a subset of goods (at world or domestic prices) be maintained at a fixed level. Despite the presence of the optimum tariffs (appropriately modified to reflect the addition of the non-economic objective), we will need to intervene through production tax-cum-subsidies in all non-numeraire sectors; an intervention that is targeted exclusively at the sectors included in the non-economic objective will, in general, be insufficient to reach the optimum.

Kemp and Wan (1976) theorem on customs unions. According to this result, there necessarily exists a customs union which allows two countries, whose trade regimes are distorted initially by tariffs, to improve their joint welfare without making the rest of the world worse off. The customs union involves eliminating all intra-union trade barriers and choosing the common external-trade-tax vector in such a way that it leaves the union's joint trade vector with the outside world unchanged. The reason for this result is that in the initial equilibrium the only distortions, from the union's viewpoint, are tariffs, which always lead to suboptimal levels of intra- and extra-union trade. Therefore, by Corollary 1, a removal of intra-union trade barriers, holding the extra-union-trade vector constant by choosing appropriately the common-external-trade-tax vector, improves the union's welfare. Moreover, since the extra-union trade vector is unchanged, the rest of the world is not hurt by the union.[16]

Before we proceed to the next section, it is useful to present briefly the optimization problem corresponding to an open economy. This exercise serves three purposes. Firstly, since most of our examples are set in an open-economy context, it gives us an opportunity to verify them directly. Secondly, the model illustrates the principle behind Proposition 1 in the two-constraints case. Finally, the model also offers an example which admits choice variables that enter one of the constraints but not the objective function.

In an open-economy context, we must distinguish between quantities consumed and produced and also introduce trade opportunities available from the offer surface of the foreign country. Again letting c_i denote the consumption of good i and $\mathbf{c}$ the vector of all c_i, we can denote the offer surface by $H(\mathbf{c} - \mathbf{x}) \leq 0$, where $H_i(.) > 0$. In the small-country case, $H = \Sigma_i \; p_i^*(c_i - x_i)$, where p_i^* is the exogenously given world price of good i. Thus, we obtain $H_i = p_i^*$. The first-best maximization problem is now given by

$$\max_{c_i, x_i, \lambda, \rho} \Psi = F(c_0, c_1, \ldots, c_n) + \lambda(s - G(x_0, x_1, \ldots, x_n)) - \rho H\,(c_0 - x_0, c_1 - x_1, \ldots, c_n - x_n). \tag{12}$$

It is easy to check that the first-order conditions imply:

$$\frac{F_i}{F_0} = \frac{G_i}{G_0} = \frac{H_i}{H_0}, \quad i \in \mathbf{I}. \tag{13}$$

[16]Importantly, Corollary 1 also opens the way to proving a theorem on the existence of necessarily welfare-improving free trade areas — a result that has thus far eluded researchers since the Kemp–Wan construction requires a common external tariff which cannot be imposed on FTAs. See Panagariya and Krishna (1997), where this result is demonstrated formally. Additionally, using the logic identical to that expressed in Corollary 1, the Cooper–Massell–Johnson–Bhagwati proposition which states that two countries can necessarily form a welfare-improving customs union even if they are constrained by specific non-economic objectives such as, say, the level of output in a specific sector, was proved formally in a recent paper by Krishna and Bhagwati (1997).

Here H_i/H_0 is the marginal rate of transformation between goods i and 0 along the foreign country's offer surface. In the small-country case, this marginal rate of transformation coincides with the terms of trade and free trade guarantees (13). But in the large-country context, H_i/H_0 is different from the terms of trade that are determined by the average rate of transformation along the foreign offer surface. It follows that except in the small-country case, condition (13) will have to be supported by a set of trade taxes that align domestic prices with marginal rather than average rates of transformation along the foreign offer surface.

The reader can now verify that if we wish to restrict a subset of choice variables directly or subject the economy to non-economic objectives defined entirely over the latter, we will still want to satisfy condition (13) for the remaining variables. Thus, in the presence of quantitative restrictions on a subset of sectors or a non-economic objective defined entirely over this subject, the optimum tariff rule in equation (13), obtained in the first-best problem, must still be satisfied for the remaining sectors. In the small-country case, this means free trade in sectors not subject to quantitative restrictions. On the other hand, if we wish to fix the tariff on one or more goods at a level different from that dictated by (13), we will want to violate (13) for all goods. Thus, Proposition 1 is verified for the open-economy context.

3. Comparative statics with unchanging distortions

In this section, we consider comparative statics with respect to parameters of the model in which a change which is favorable (unfavorable) in the first-best situation may or may not turn unfavorable (favorable) in a second-best situation. In terms of the closed-economy model of the previous section, we ask how growth, aid or resource destruction impact welfare. The key to our discussion in this section is

Proposition 2. *Suppose that an exogenous parameter enters either the objective function or one of the constraints. An exogenous change in this parameter that increases the maximized value of the objective function in the first-best problem continues to do so in the presence of exogenous constraints on a subset of choice variables and/or one or more exogenous constraints defined entirely over this subject. The change may fail to increase the value of the objective function, however, if a subset of first-order conditions of the first-best problem is violated.*

In our simple model, so far, the only exogenous parameter is s. A rise in this parameter can be viewed as capturing the effect of growth in the factors of production or technological improvement that helps expand the production possibilities set. Alternatively, a reduction in s can be viewed as representing a withdrawal of resources from productive activities. Our model can be augmented further by the introduction of another set of parameters which may be identified with foreign aid. Thus, denoting aid in terms of good i by $e_i \geq 0$, we add it to x_i in $F(.)$ but not $G(.)$. In this manner, the quantity of good i consumed exceeds the quantity of that good produced by the amount of aid. The first-best problem under this modification is the same as (1) with $F(\mathbf{x})$ replaced by $F(\mathbf{x}+\mathbf{e})$, where $\mathbf{e}$ is the vector of all e_i. Denoting the envelope function associated with this problem by $\theta(\mathbf{e},s)$, we immediately see that $\partial\theta/\partial e_i = F_i > 0$ and $\partial\theta/\partial s = \lambda$ or, using optimality condition (2), $\partial\theta/\partial s = F_i/G_i > 0$. Thus, an increase in aid and growth increase the value of the objective function while a reduction in aid and DUP reduces it.

Suppose now that we exogenously fix variables $k \in \mathbf{K}$ below a prespecified level. The optimization problem is then given by (5) with parameters $e_i \leq 0$ added to the x_i in $F(.)$ but not $G(.)$. The envelope function associated with this problem can now be written $\phi(\mathbf{e}, s, \bar{\mathbf{x}}_{\mathbf{K}})$, where $\bar{\mathbf{x}}_{\mathbf{K}}$ is the vector of all $\bar{x}_k$. The envelope function has the properties $\partial\phi/\partial e_i = F_i > 0$ and $\partial\phi/\partial s = \lambda = F_i/G_i > 0$. Thus, even if a subset of choice variables is restricted exogenously, a rise in the parameters e_i and s which can come about due to increased aid and growth, respectively, is favorable and a decline in them which may result from decreased aid and increased DUP, respectively, is unfavorable. The same result can be shown to hold if we add one or more constraints defined over a subset of choice variables.

Finally, instead of fixing choice variables k or introducing one or more constraints defined entirely over them, assume that first-order conditions of the first-best problem associated with variables $j \in \mathbf{J}$ are violated. The optimization problem in this case is given by (4) after we replace $F(\mathbf{x})$ by $F(\mathbf{x}+\mathbf{e})$. But when we solve (4), we violate all first-order conditions of the first-best problem. Therefore, the envelope function associated with it cannot be used to evaluate the impact of a change in s on the objective function when only a subset of the first-order conditions of the first-best problem are to be violated.

To see how the value of the objective function changes when we change the e_i and s in this case, toally differentiate the (modified) objective function and the constraint. We have

$$\mathrm{d}F = \sum_{i\in\mathbf{I}} F_i(\mathrm{d}x_i + \mathrm{d}e_i); \quad \sum_{i\in\mathbf{I}} G_i \mathrm{d}x_i = \mathrm{d}s. \tag{14}$$

For $i \notin \mathbf{J}$, (2′) gives the first-order conditions. For $j \in \mathbf{J}$, the first-order conditions are $F_j/F_0 = (1+t_j)G_j/G_0$. Substituting from these conditions, the two equations in (14) can be combined to yield

$$\frac{\mathrm{d}F}{F_0} = \frac{1}{G_0}\left[\sum_{i\in\mathbf{I}} G_i \mathrm{d}e_i + \sum_{j\in\mathbf{J}} t_j G_j \mathrm{d}e_j + \mathrm{d}s + \sum_{j\in\mathbf{J}} t_j G_j \mathrm{d}x_j\right]. \tag{15}$$

To solve for the last term in (15), we must differentiate the first-order conditions and combine them with the second equation in (14). Without engaging in that lengthy exercise, we simply note that (15) opens up the possibility that the increase in s and e_i may lower the value of the objective function if the last term in it is negative and large, i.e. if sectors that are subject to taxes contract sufficiently.

Correspondingly, a decline in s may lead to a rise in the value of the objective function if the taxed sectors expand sufficiently. Whether or not these results actually arise depends on the structure of the model.

Fig. 1 illustrates Proposition 2 for the two-good case. Initially, there is no aid and the economy is constrained to consume along its production possibilities curve. If we quantitatively restrict x_1 at $\bar{x}_1$, growth or aid in terms of good 0, which moves the set of feasible x_is outside the production possibilities shown in Fig. 1, moves the optimal solution up along $\bar{x}_1\bar{x}_1$ representing a higher value of this objective function. If aid comes partially in terms of good 1, we move to north east of the initial consumption point which is also a welfare-improving change. If, on the other hand, the restriction violates the first-order condition of the first-best problem by fixing $t_1 > 0$, the outcome is ambiguous. Thus, if aid or growth moves the system along or to the right of $\bar{x}_1\bar{x}_1$, the value of the objective function must rise. If we move to the left of $\bar{x}_1\bar{x}_1$, the change has an ambiguous effect on the value of the objective function. Before we proceed to a discussion of the results from the literature which follow from Proposition 2, it is useful to consider the

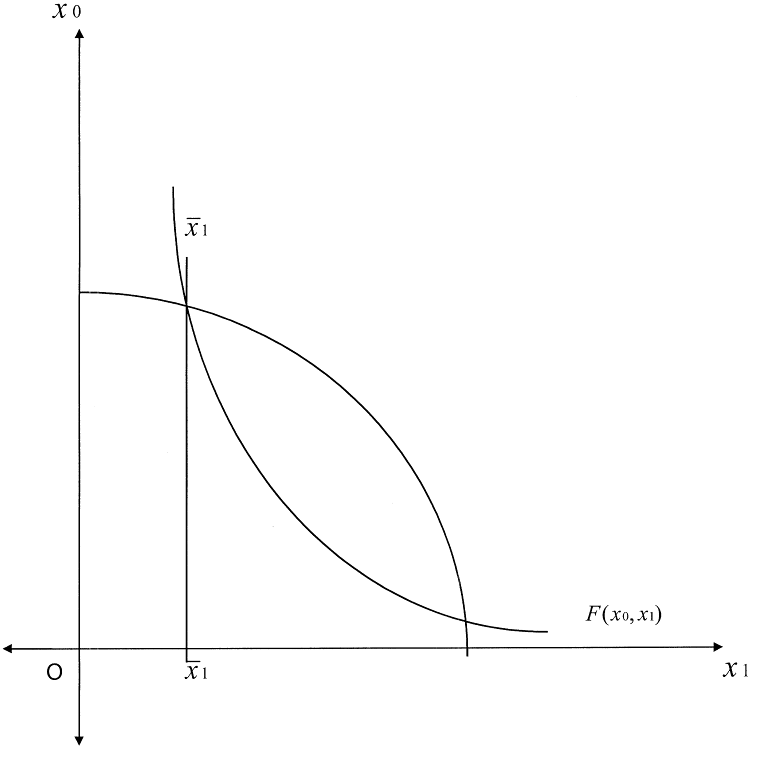

Fig. 1. Welfare changes with growth and aid: price versus quantity distortions.

small-open-economy analog of expression (15). Here the objective function is $F(\mathbf{c}+\mathbf{e})$ with other equilibrium conditions given by $G(\mathbf{x})=s$, $\Sigma_i\ p_i^*(c_i-x_i)=0$, $F_i/F_0=G_i/G_0=p_i^*/p_0^*$ for $i\not\in\mathbf{J}$, and $F_j/F_0=G_j/G_0=(1+t_j)p_j^*/p_0^*$ for $j\in\mathbf{J}$. After manipulations similar to those done to obtain (15), the above equations can be combined to derive:

$$\frac{\mathrm{d}F}{F_0}=\frac{1}{G_0}\left[\mathrm{d}s+\sum_i G_i\mathrm{d}e_i+\sum_j t_jG_j\mathrm{d}e_j\right]-\sum_i(c_i-x_i)\frac{\mathrm{d}p_i^*}{p_0^*}+\frac{1}{G_0}\sum_j t_j\,G_j(\mathrm{d}c_j-\mathrm{d}x_j). \tag{16}$$

This expression resembles (15) with two differences. Because the context of (16) is that of a small, open economy and the distortion is in the form of tariffs, the last term in it contains $(\mathrm{d}c_i-\mathrm{d}x_i)$ instead of $\mathrm{d}x_i$. Moreover, due to the presence of an additional constraint provided by the foreign offer surface, (16) has one extra term (the penultimate term) that captures the exogenous change in the terms of trade. The terms of trade improve or worsen as the sum of import-weighted prices falls or rises or, equivalently, $\Sigma_i(c_i-x_i)\mathrm{d}p_i^*$ is negative or positive.

Let us now consider examples from the literature that follow from the underlying logic of Proposition 2. Firstly, in the two-factor, two-good model, Bhagwati (1958) demonstrated the possibility of immiserizing growth in a large, open economy which trades freely in international markets. As was noted by Bhagwati, this result arises because, in the absence of the optimum tariff (i.e. violation of (13) in our multi-good formulation), the initial equilibrium does not satisfy the first-order conditions of the first-best problem. An interesting implication of our analysis, which follows from the first half of Proposition 2, is that if all trade is regulated by binding quotas, irrespective of whether or not these quotas mimic the optimum tariff, welfare must rise in response to growth (see Alam, 1981).[17]

Secondly, Johnson (1967) has noted the possibility of immiserizing growth in a small, open economy in the presence of a tariff. Once again, in terms of our analysis, this possibility arises because, in a small, open economy, the first-order conditions of the first-best problem require free trade in all goods and a tariff violates them. It is immediately obvious from Proposition 2, however, that if we replace the tariff by a quota in this problem, growth cannot be immiserizing.

Thirdly, Bhagwati and Srinivasan (1982) have shown that in a small, open economy, DUP activities which take away resources from directly productive activities can increase welfare in the presence of a tariff but not a quota. Though

[17] This result is readily verified by adding quotas on net imports of goods $1\ldots,n$ to the problem in (12) and then using the associated envelope function to show that a rise in s leads to a rise in the value of the objective function.

this result has been derived for a two-sector economy, it extends easily to our multi-good context: if one or more goods are subject to tariffs, DUP activities can improve welfare but if the restriction takes the form of import quotas, they cannot do so.

Fourthly, Kemp and Negishi (1970) and Eaton and Panagariya (1979) have shown that in the presence of external economies, an improvement in the terms of trade of a small, open economy may reduce welfare. The possibility of a welfare loss due to an improvement in the terms of trade also arises if there are no externalities but one or more goods are subject to production taxes, consumption taxes or tariffs. Following Proposition 2, the first of these two results cannot arise if the goods characterized by external economies are subject to binding output quotas and the second one cannot arise if consumption, production or imports, respectively, are distorted by binding quantitative restrictions on the corresponding variables. The possibility of a welfare loss from an improvement in the terms of trade in the presence of tariffs can be seen from (16). The effect of this change is given by the last two terms in square brackets of which the first (inclusive of the minus sign) is positive by assumption and the second can be negative.

Fifthly, in the same vein, Eaton and Panagariya (1982) have shown that growth can be immiserizing in a small, open economy in the presence of external economies, production and consumption taxes and tariffs. Once again, in view of Proposition 2, this possibility will be ruled out if the goods characterized by external economies are subject to output quotas or if taxes are replaced by quantitative restrictions.

Sixthly, as a straightforward extension of the results of Kemp and Negishi (1970) and Eaton and Panagariya (1979, 1982), it can be deduced from Proposition 2 and expression (16) that increased foreign aid can lower a small country's welfare in the presence of production and consumption taxes or tariffs but not quantitative restrictions on production, consumption or imports.

Finally, Brecher and Diaz-Alejandro (1977) have shown that in the two-factor, two-commodity model of a small economy, an inflow of capital in the presence of a tariff is necessarily harmful if the country imports the capital-intensive good. This result can be inferred from Proposition 2 or, more accurately, expression (16) by recognizing that a capital inflow within our framework works by augmenting s. In a two-factor, two-good small, open economy, capital inflow has no effect on factor prices. This leads to the conclusion that a small increase in the inflow raises the repatriation of the return on foreign capital by $\mathrm{d}s/G_0$ so that the change in welfare depends entirely on the last term in (16). Since the import good is capital intensive, the capital inflow expands the output of the import-competing good and reduces imports, making the last term in (16) unambiguously negative. Thus, the Brecher–Diaz-Alejandro result follows. An implication of Proposition 2, however, is that if the restriction on imports takes the form of an import quota, welfare cannot decline due to the capital inflow.

4. Piecemeal policy reform

So far, we have held the levels of distortions fixed and studied the effects of changes in parameters of the first-best problem on the objective function. We now study the effect of a gradual reduction in one or more distortions on the value of the objective function. This exercise takes us into the world of piecemeal policy reform. We begin by considering a gradual relaxation of restrictions on choice variables.

Proposition 3. *Suppose we subject a subset of choice variables to binding restrictions* (*i.e. quantitative restrictions in the usual contexts*) *but satisfy the first-order conditions of the first-best problem with respect to all other variables. If we now relax the restrictions on the choice variables in small or large steps either sequentially or simultaneously while continuing to satisfy the other first-order conditions as obtained in the first-best problem, the value of the objective function rises monotonically.*

The proof of this proposition follows from the simple observation that the value of the objective function cannot fall when a constraint is relaxed and that it will rise if the constraint was binding. We offer three examples from the literature which follow from Proposition 3. Firstly, Meade (1955a) noted that if all trade barriers take the form of quantitative restrictions, a removal of the barriers between two countries forming a preferential trading area must increase global welfare. Because Meade focused on global welfare, the terms of trade changes that redistribute income among countries were of no consequence. If maximization of global welfare is the objective, the first-best solution requires global free trade and no other interventions. Therefore, if quantitative trade barriers are the only restrictions, the conditions of Proposition 3 are satisfied: a subset of choice variables is subject to direct constraints with all other conditions of the first-best problem satisfied. A relaxation of the restrictions necessarily increases the value of the objective function. Though stated with respect to trade barriers between union members only, the result naturally applies to a removal of trade barriers anywhere including countries outside the union.

Secondly, Wooton (1988) has shown that if a customs union sets the common external tariffs optimally and relaxes internal factor mobility, its joint welfare necessarily rises. Because the initial restriction on factor mobility in this analysis is assumed to be quantitative and optimality conditions with respect to other choice variables of the customs union are satisfied through common external tariffs, this result follows immediately from Proposition 3. Indeed, though Wooton does not recognize this, if *all* extra-union trade is subject to binding quotas, irrespective of whether or not such quotas mimic optimum tariffs, increased factor mobility improves joint welfare of the customs union.

Finally, Corden and Falvey (1985) have demonstrated that in a small, open economy, if quantitative barriers are the only trade restriction, their removal is beneficial irrespective of the sequence or size of increments in which they are relaxed. Though Corden and Falvey did not prove this, an immediate implication of Proposition 3 is that their result can also be applied to a large country provided the goods not subject to quotas are subject to optimum tariffs and provided quota liberalization on a good does not go beyond the level of imports that will be achieved under the optimum tariff on that good. Recall that optimum tariffs ensure that the first-order conditions of the first-best problem are satisfied for all variables not subject to quantitative restrictions.

It is well known that a result similar to Proposition 3 does not hold for distortions arising out of the violation of a subset of first-order conditions of the first-best problem while satisfying the others, or what are otherwise called price distortions. Specifically, if we violate two or more first-order conditions of the first-best problem, there is no guarantee that restoring them gradually and sequentially will increase the value of the objective function every step of the way. The voluminous literature on piecemeal reform is aimed precisely at searching for rules which allow for the gradual restoration of violated first-order conditions, that yielding an increase in welfare every step of the way.[18]

5. Conclusions

The propositions in this paper provide a general treatment of optimal policies in the presence of preexisting price and quantity distortions in perfectly competitive systems and have applications in many areas of applied microeconomic theory. The paper clarifies how, in many optimization problems in economics, pre-imposed quantitative restrictions enter differently from price restrictions. The implications of this difference for the conduct of second-best optimum policy are

[18]While strong results similar to Proposition 3 cannot be obtained for price distortions, it can be shown that the form of the conditions under which welfare improves with piecemeal reform of price distortions in the presence of unchanging quantitative distortions. Thus, for example, the piecemeal tariff reform result due to Bertrand and Vanek (1971) and Hatta (1977) whereby in a small open economy with tariffs as the only distortion a reduction in the highest tariff down to the next highest one improves welfare provided the good with the highest tariff exhibits substitutability in consumption and production with all other goods can be shown (Falvey, 1988) to remain valid in the presence of import quotas on some goods provided these latter goods exhibit substitutability in consumption and production with all other goods. Similar piecemeal tariff reform results relating to world welfare found in Meade (1955b), Fukushima and Hatta (1979) and Neary (1995) can be shown to be robust to the presence of quantitative restrictions as also the results of Bruno (1972) and Fukushima and Hatta (1979) on proportionate tariff reforms and Neary (1995). Indeed, even the Lerner symmetry theorem turns out to be valid in the presence of quantitative restrictions (Lopez and Panagariya, 1995). While we do not discuss these results here in any detail due to space constraints, the interested reader can find them in Krishna and Panagariya (2000).

also analyzed as are the general conditions under which the presence of distortions in some sectors does not undermine the case for non-intervention in other markets. These results serve to unify a diverse literature which, mostly unbeknownst to itself, is built around just this point. We have offered several new results in the paper as well.

Acknowledgements

We are grateful to Jagdish Bhagwati, Avinash Dixit, Alan Deardorff, Vivek Dehejia, Don Davis, Phoebus Dhrymes, John Driscoll, Ronel Elul, Murray Kemp, Tom Krebs, Anne Kreuger, Peter Neary, Dani Rodrik, Harl Ryder, Robert Schwab, Bent Sørensen, George Stergios, Oscar Volij, David Weil and seminar participants at the University of Michigan, University of Maryland, University of Pennsylvania, and Pennsylvania State University for helpful comments. Pravin Krishna gratefully acknowledges the hospitality and intellectual and financial support of the Center for Economic Development and Policy Reform at Stanford University, where part of this research was completed.

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