Could the desire for a better environment lead to political options against free trade?: Insights from MERCOSUR

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Abstract.

In a world where externalities are not corrected by optimal environmental policies, if trade openness leads to lower environmental quality it might also reduce welfare. The aim of this paper is to explore how this would be likely to happen in the MERCOSUR area, using results obtained from a world commerce general equilibrium model. We will first show a basic theoretical model useful to evaluate the welfare effect of different liberalisation scenarios in a second best world where environmental externalities are not efficiently corrected. Secondly we present a welfare evaluation function to evaluate the desirability of a certain degree of trade liberalisation and present the evidence from MERCOSUR.. Finally, if pollution taxes are not easy or not worth implementing, we will see whether it would be preferable to maintain or increase the existing trade barriers.

Key words: Trade and environment, MERCOSUR, Global CGE model.

JEL Codes: F13, F14, F15, O13, Q2, Q4

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COULD THE DESIRE FOR A BETTER ENVIRONMENT LEAD TO POLITICAL OPTIONS AGAINST FREE TRADE?: INSIGHTS FROM MERCOSUR

I. INTRODUCTION

Many steps further have taken place in the way to a more open framework for international trade around the world, and particularly in less developed areas during the last few decades. In clear opposition to that fortunate pattern, the development and practical enforcement of efficient environmental policies have been less noticeable and in many countries (especially less developed ones) the enforcement of property rights on the environment, is far from being optimal. The opposition between these two apparently diverging patterns makes one wonder whether, in the presence of important environmental distortions, trade liberalisation between poor and rich countries or amongst poor countries through custom unions or trade blocks, is desirable (e.g., Chichilnisky, 1994). In this context, it is easy to understand how in recent years the issue of trade liberalisation as an environmental problem has emerged as an important topic in trade policy analysis (Anderson and Blackhurst, 1992; Copeland and Taylor, 1994).

The first relevant question to be solved is whether trade liberalisation is coupled with environmental degradation. Advocates of free trade argue that if environmental quality is a superior good, or even a normal one, income increases will create a political demand for efficient institutions and tighter environmental standards. This pattern will also act in favour of the setting of less polluting techniques (e.g. Bhagwati and Daly, 1995; Carraro et. al, 1995). Pessimists about technical and institutional changes, argue that since trade increases the scale of economic activity, pollution must rise with trade liberalisation (e.g. Daly, 1996). Things can also be complicated if, apart from the positive effects of technology and institutions and the negative effects of an increased activity, we consider the fact that trade liberalisation will shift the output composition of the economy in a way that could actually induce additional pressures on the environment (when comparative advantages are in dirty goods, the absence of environmental policy instruments may attract dirty industries), or rather the opposite (when clean goods or low pollution intensive goods have comparative advantages). The sign ambiguity of trade openness effects over the environment and the absence of a general theory able to capture the complex nature of the above mentioned problem, are important reason why different authors (e.g. Grossman and Krueger, 1991; Beghin et. al, 1996 and and Strutt and Anderson, 1998) have investigated the empirical significance of each of these effects. One of those research efforts is the GTAP-ENV model (Gómez, C. 2002) which has been used to compare the environmental effects of a detailed array of environmental indicators in different liberalisation scenarios in the MERCOSUR area.

Although we will use the GTAP-ENV model in this paper, our main task goes one step beyond of the environmental impact of trade openness. Even in the worst event, increased pollution levels or natural resources depletion do not necessarily mean reduced economic welfare. The second (and most relevant from an economic perspective) question is whether trade liberalisation could damage both the environment and human welfare. Many possible answers can be obtained both from theoretical and empirical economic research. On the one hand many authors have investigated the effects of pollution policy on trade pattern (Pethig, 1976; Siebert et. al. 1980; McGuire, 1982 and Baumol and Oates, 1992) by extending the two good and two country Ricardian model. Yet in all those models environmental policy is exogenous. On the other, some authors could neglect the eventual conflict between the welfare effects of trade freedom and the environment by assuming that in any trade scenario pollution is always optimal, since the government will always adjust environmental policies according to changing economic circumstances (Copeland and Taylor, 1994 or Corden, 1997). Finally, there is a lot to be read on the second-best optimal choice of both pollution and trade instruments in a single open economy (Baumol and Oates, 1992, Copeland, 1994, Neary, 2000).

Whatever the case, these three research lines above mentioned help confirm that, even in the presence of externalities, trade liberalisation always leads to a welfare improvements, provided optimal environmental policies have been set up. Moreover, when environmental externalities are not efficiently corrected by the enforcement of property rights or by optimal environmental taxes, welfare gains associated to trade liberalisation can be lower than when trade barriers are the only distortion in the economy and when, at least theoretically, extended environmental degradation and resource depletion can outweigh welfare gains derived from trade. The issue of whether trade liberalisation is beneficial in the presence of non-optimal pollution regulations is also relevant from a political perspective. The possibility that, in real circumstances, increased trade freedom could affect in a negative way both the environment and welfare, and in some cases the pessimism that dominates the way one sees the relationship between human beings and their environment, is the basic inspiration source of many arguments against the process currently known as globalisation (e.g. Daly, 1996).

Unfortunately, in the presence of such complex relevant interactions between trade liberalisation, economic distortions and the environment, partial analysis can only lead to partial answers from which it is hard to draw general conclusions (see Anderson et. al, 1992 for an exposition of the many opposing effects that can be obtained from trade openness in partial equilibrium analysis). Within this context, applied general equilibrium models can provide us with some valid insights about the empirical relevance of some interactions and environmental effects of trade liberalisation. The aim of this paper is to provide a methodology and to illustrate the case with the results that could be expected in different scenarios of trade liberalisation in MERCOSUR area.

Our purpose is to contribute to that discussion by trying to draw out some general insights from an empirical general equilibrium model of world commerce which was used to assess the economic and environmental impact of different trade scenarios in MERCOSUR. Although the model is able to compute and decompose the different effects of any trade shock over a set of environmental indicators, our focus is not so much on the environmental but rather on the overall welfare effects of trade openness. A main challenge stems from the fact that the answer of whether a particular trade shock would improve or deteriorate welfare will be heavily dependant on the agent structure of preferences, and particularly on the marginal willingness to pay for improved environmental quality. As consumers do not reflect these preferences in any market, market prices usually obtained in general equilibrium simulations do not convey any information on lower pollution preferences. Nevertheless, when extended to include environmental impacts, applied general equilibrium models can provide detailed information on how the economy would adapt after a policy shock have taken place and these results can be a useful starting point for a welfare assessment.

Given these limitations, the specific questions we would try to answer are of the following kind; given that a particular policy (e.g. trade liberalisation) is applied in an institutional setting where there are other economic distortions (typically a sub-optimal environmental policy or whatever distortional tax on capital and labour), how likely is it that its welfare effects might be negative? Having dealt in the next section with a basic second-best theoretical model for the evaluation of environmental and trade policies in a general equilibrium framework, we then present the many possible welfare consequences of trade liberalisations depending on both the physical impact these policies would have on pollution and the local marginal willingness to pay for a better environment. The computable general equilibrium model used to analyse the likelihood of any possible result of trade liberalisation is presented in the third section. We then proceed with the welfare evaluation function that will be used in the following sections so as to analyse the three following questions with the help of many trade liberalisation scenarios: First, might preferences for lower pollution levels and increased resource conservation make a restricted liberalisation preferable to a deep liberalisation policy option? Second, if we expect that current sub-optimal environmental policy will be maintained, given certain preferences for pollution and resources, would it be desirable to maintain, increase or reduce current export taxes? Third, in the context of the current trade barriers and other economic distortions, what sign in welfare variation could be expected if taxing heavily polluting goods have?

II. A BASIC SECOND-BEST GENERAL EQUILIBRIUM MODEL:

In this section we present the basic model to analyse second-best trade reforms. The model is based on the standard competitive model of a small open economy, presented by Neary (2000) as a generalization of a family of models to study the simultaneous reform of trade and environmental policies developed by Copeland (1994), Beghin, et. al. (1996), and Meary and Schweinberger (1986). We show that any answer to the questions set above will critically depend on both the sign of the environmental (or physical) impact of trade liberalization, and on the marginal willingness to pay of locals for a better environment.

Let us assume a price-taking economy which produces and consumes n goods, in quantities x, and h bads in quantities measured by a vector z of pollution effluents. The goods prices are p in the local economy and p^* the international price level, and the difference is explained by the existence of trade taxes ($r=p-p^*$). Emissions are generated in production processes and can be internalised by a set of environmental taxes t (likely to be zero).

Consumer's preferences and behaviour:

There is a single aggregate household whose preferences are represented by the expenditure function:

$$e(p,z,u) \equiv \underset{q}{Min} \{p.q \mid u(q,z) \geq u\} \quad (1)$$

Utility increases with consumption and decreases with pollution ($u_q>0;\ u_z<0$). And, according to the Sheppard Lemma:

$e_p=q$

e_z is the household's marginal willingness to pay for reductions in emissions.

Production:

Production is represented by a gross national product function:

$$g(p,t) = \underset{x,z}{Max} \{p.x - t.z \mid F(x,z \leq 0\} \quad (2)$$

Where: x is the net output of goods, z is the net output of pollution and the production frontier $F(x,z)$ depends on technology and the local endowment of production factors and natural resources. According to the Hotelling's Lemma:

$g_p=x$

$g_t=-z$

Following Neary (1985), the GNP function (2) can be written as $g(p,t)= \bar{g}(p,z)-t'z$; where $\bar{g}(p,z)$ is a pollution constrained indirect production function. Holding z constant we can deduce that:

$g_z(p,z)=t$

Summing up from the previous expressions we can obtain:

$m = e_p - g_p$ the net imports of goods.

Trade:

The trade expenditure function can be written as:

$$E(\pi, z, u) \equiv e(p, z, u) - g(p, t) \qquad (3)$$

Where, π is a $n+h$ vector formed by the set of good prices (p) and pollution taxes (t). The derivative of the trade expenditure function with respect to the full price vector E_π is the vector of net imports and emissions $(m,z)^T \varepsilon\ R^{n+h}$. Note also that the second derivative of the trade expenditure function with respect to the price vector $E_{\pi\pi}$ is negative definite.

Equilibrium:

The Government collects tariffs and environmental taxes that are returned to the household consumer in a lump-sum way. The overall balance condition for the economy implies that in equilibrium net expending must equal redistributed tax and tariff revenue[1]:

$$E(\pi, z, u) = r'm + t'z \equiv \tau\, E_\pi(\pi, z, u) \qquad (4)$$

Completely differentiating with respect to z, u, and m, the basic first-best first order condition is obtained as:

$$e_u du \equiv r'dm + (t' - e_z)dz \qquad (5)$$

From which it is possible to draw the general conclusion that in a first-best world, free trade ($r=0$), combined with a set of pigouvian taxes (equal to the consumer's marginal willingness to pay for pollution abatement, or $t=e_z dz$) leads to maximum welfare.

[1] Note that: $r.m + t.z = \tau\, E_\pi(\pi, z, u)$. Where τ is the tariff and taxes column vector $(\tau=(r, t))$.

To transform the first order condition into an overall equilibrium expression useful for policy evaluation we need to eliminate, from equation (5), the endogenous differentials *dm* and *dz*, representing the marginal variation of net imports and pollution, and show them as the optimal response of the economy to the changes in the policy environment including both, marginal changes in tariffs and taxes. This transformation, explained in Appendix A, leads to the following second-best general equilibrium condition:

$$(1 - rX_I)e_u du = (r')\lfloor E_{pp}dr + E_{pt}dt \rfloor + (t' - e_z + re_{pz})\lfloor E_{tp}dr + E_{tt}dt \rfloor \qquad (6)$$

This is the basic equation of the second-best general equilibrium policy evaluation model. In normal brackets we have the three main price distortions of the economy (the exchange rate shadow price on the left hand side, and the tariffs and the pollution price distortion on the right hand side). In square brackets we have the quantity impact of marginal changes in both, tariffs and environmental taxes.

The term on the left hand side is the monetary measure of the welfare improvement ($e_u du$), corrected by the "shadow price of foreign exchange"[2] (or: $(1\text{-}r'x_I)^{-1}$). In the first term on the right hand side, we have the import tariff (r'), or the trade distortion, multiplied by the joint effect over net imports of marginal changes in tariffs and taxes. The second term on the right hand side is the product of the "environmental price distortion" measured by the deviation of current taxes (t`) from the consumer's marginal willingness to pay for a pollution reduction (e_z) and the indirect marginal cost of the tariff induced pollution (re_{pz}). This "environmental price distortion" is multiplied by the marginal change in emissions produced both by marginal changes in tariffs and environmental taxes.

From the general model represented in equation (6), one can state that without institutional and any other policy constraints, the first-best policy consists in both the suppression of import tariffs ($r=0$) and the setting of an environmental tax equal to the consumer's marginal willingness to pay for a reduced pollution[3].

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[2] According to Neary (1995) the term x_I is the vector of Marshallian income derivatives (defined by: $x_I e_u = e_{pu}$).

[3] We can also say that, starting from an actual sub-optimal situation, as proved by Copeland (1994), any policy change that reduces both distortions in the same proportion, would lead to a welfare improvement; see Neary (2000).

Let us now consider the second-best case and assume that only one policy instrument is available. If environmental taxes cannot be changed (*dt=0*), and trade liberalisation is possible *dr<0,* the second-best optimal tariff is not zero and its value will depend on the environmental tax gap. Setting *dt=0*, for the situation where welfare gains do not exist ($e_u du=0$), we can solve the second-best optimal tariff as[4]:

$$r'^{*} = -(t' - e'_z + r' e_{pz}) E_{tp} (E_{pp})^{-1} = -(t' - e'_z + r' e_{pz}) g_{tp} (E_{pp})^{-1} \qquad (7)$$

Meaning that if the set of environmental taxes cannot be modified, the other set of policy instruments (tariffs) should systematically deviate from its first-best level.

The first basic conclusion is that the sign of the relation between second-best tariffs and pollution taxes depends on the quantitative response of emissions to tariffs (that is to say, the sign of the matrix $g_{tp}=-z_p$), which opens many possibilities for the welfare effect of trade liberalisation in real economies.

We can now analyse two general situations depending on the effect of liberalisation on pollution. First, let us assume an optimistic scenario where the combined effect of the change in scale, composition and technical effect of trade liberalisation over the environment leads to lower pollution (that is to say: $z_p<0$ or, equivalently: $g_{tp}=-z_p>0$). In that case the second-best optimal tariff is an increasing function of the pre-specified level of environmental taxes[5], as shown in Figure 1 panel (a). If, in this situation, the current environmental tax is weak ($t'-e'_z+r'e_{pz}<0$), it would be optimal to subsidise imports to reduce pollution, and liberalisation would always improve both the environment and welfare. In fact, as shown in Figure 1.a, the optimal second-best tariff will be negative (if pollution taxes are in their first-best values, the optimal tariff is zero). If liberalisation reduces pollution and the environmental policy is lax ($t'<e'_z$), net imports would need to be subsidised in order for this to be.

Figure 1, also shows the iso-welfare contour corresponding to current sub-optimal environmental policy, and we can easily solve the second-best optimal subsidy (or negative tariff), as the iso-welfare contour that is tangent to the vertical line passing through *t'*. Similarly, we can also say that if trade liberalisation reduces pollution, it will

4. The derivation of the second best equilibrium is presented in Appendix A.

[5] This is a consequence of the fact that the matrix $E_{pp}=e_{pp}-g_{pp}$ is negative definite and its inverse positive.

decrease welfare if and only if pollution taxes are higher that household's marginal willingness to pay for reduced pollution (and we are on the right of the first- best environmental tax in Figure 1.a).

On the contrary, in the less optimistic scenario, a reduction in trade barriers will have a negative effect on the environment. This happens when the overall effect of a reduction in tariffs, taking into account the scale composition and technical effect, increases pollution (that happens when $g_{tp}=-z_p<0$). Following a symmetric argument we can conclude that in this case the second-best optimal tariff will be an increasing function of the given set of environmental taxes as shown in Figure 1.b. If in the current situation environmental policy were weak ($t'<e_z$), this distortion would need to be compensated with a positive tariff in order to reduce pollution. If current tariffs were high enough, a restricted trade liberalisation scenario would lead to a positive welfare improvement until the optimal second best set of tariffs is reached (as happens in Figure 1.b, when the environmental tax is set at t'. In a similar way if environmental taxes are high ($t'>e'_z$), trade liberalisation will always improve welfare[6].

Summing up: the welfare effects of trade liberalisation critically depend on the physical effects of trade barrier removal over the environmental quality and on the deviations of current environmental taxes from household marginal willingness to pay for a reduced pollution.

III. EMPIRICAL TESTING THE WELFARE EFFECTS OF TRADE LIBERALISATION.

A critical issues is how to empirically test the situation at hand in a particular region of the world. To see the results that we could obtain from an empirical test of the welfare impact of trade liberalisation when environmental taxes are fixed, let us assume that we know the marginal willingness to pay of the household representative consumer (e_z) (which is obviously a heroic assumption). In that case, a computable general equilibrium model would allow us to obtain, first, the impact of a liberalisation shock on both regional

[6] A similar argument can be developed for a situation where modifications of trade barriers are not available ($dr=0$), but environmental taxes can be modified. In that case, the set of second best environmental taxes can be determined as:

$$t'^{*} = -r'E_{pt}(E_{tt})^{-1} = -r'g_{pt}(g_{tt})^{-1}$$

In that case the critical element is the responsiveness of net imports to pollution taxes ($g_{pt}=-z_p$).

monetary income and pollution and second a welfare measure, ordinarily the general equilibrium Hicksian compensating variation, over the perpendicular line passing trough current environmental taxes in Figure 1.

Moreover, in the general case, the results would critically depend on how much consumers are willing to pay for a reduced pollution. As this element of preferences is not visible, we prefer to formulate the question in a different way: how much must people value the environment in order to make a restricted liberalisation scenario preferable to free trade? Before describing the different liberalisation scenarios we proceed in the next section to describe the MERCOSUR Computable General Equilibrium Model.

A. The GTAP-ENV Model of MERCOSUR.

Our model (GTAP-ENV) is a modified version of the well-known GTAP model, with the addition of an environmental module, which has been built using the information provided by the World Bank's Industrial Pollution Production System Project (IPPS)[7]. The GTAP project (Hertel, 1997) provides a database and a model of national and international markets with an extended disaggregation of industries in countries that cover all the world economy. In its 4.0 version the model captures 50 industries and 45 regions. The main advantages of using such a computable general equilibrium model (CGE) is that it defines all the sources of economic changes by considering the expansion of the supply and demand of virtually any produced good, allowing for the interpretation of changes of economic structure produced by any adjust in the trading or policy environment.

The GTAP model is a standard comparative, static, multi-region and computable general equilibrium model of the Johansen type created by the Australian Government in the 1980s and developed during the 1990s by the University of Purdue in the United States. The model is implemented and solved with the GEMPACK software (Harrison and Pearson, 1996) and is used by a network of more than 400 researchers in more than 50 countries (see Hertel, 1997 and McDougall, 1997 for detailed information.)[8]. The model uses a flexible representation of consumer demands that allows for differences in

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[7] A detailed presentation of our AGE model is not possible in this paper and can be consulted in, Gómez (2002) and requested from the authors by e-mail. In this section we offer a very general presentation of the pieces of the model.
[8] Updated information is available in www.agecon.purdue.edu/gtap.htm

both price and income elasticities depending on the income level and local or regional consumer patterns and preferences. On the supply side the model captures differences in factor intensities among sectors which are important as driving forces in the change of the sectoral composition of output. The model distinguishes four primary production factors: capital, unskilled and skilled labour and natural resources that are combined according to separable constant returns to scale technologies. Trading goods form Armington aggregates that are combined with other intermediate inputs to produce goods with a Leontief technology. Balance conditions guarantee the levelling of demand and supply for any factor of production.

The second key piece of our empirical model is the environment. There are different alternatives to incorporate the environmental module in the general equilibrium model, and they basically range from the ambitious methodology developed by Xie Jian (1996) where many resources and waste flows are affected by the economic system, to the alternative approach developed by Conrad (1993) and Ferrantino (1999), where the quality of the environment is approximated by a single "star indicator" measuring the increase of carbon monoxide or sulphates. In any case, the characteristics of the environmental module and of the kind of interactions that can be captured in the AGE model are heavily dependent on data availability. In the GTAP-ENV model we use the database provided by the World Bank's IPPS project (see Hettige, et. al.1994), which contains many effluent sectoral intensities econometrically obtained by the OECD (see Holst et.al, 1994), and data from a survey of more than 200,000 firms, and was adapted to developing countries. The IPPS system distinguishes 14 sectoral intensities (in 28 sectors) defined in pounds per million of 1987 US dollars of added value, separated in toxic and cumulative pollution, air pollution, and water pollution.

In order to make this information compatible with the GTAP database, and to cope with the lack of detailed information for some environmental indicators and for some countries, the final model needed to be reduced by data grouping. The final version of the GTAP-ENV model includes 8 regions, 12 sectors and 13 effluent intensities. The main components of the model are included in Appendix 1.

B. Welfare Evaluation Function:

The regional per-capita utility positively depends on the total expenditure in market goods (*Y)* (including, private and public expenditure on consumption and investment) and also on the environmental quality (*Q)* (a negative function of total pollution). All variables are normalised to the unity in the baseline (that is to say $(Y_0, Q_0)=(1,1)$).

A fairly general CES representation of this regional per-capita utility function is:

$$U_f = (\alpha\, Y^{-\rho} + \beta\, Q^{-\rho})^{-1/\rho} \qquad (1)$$

Where:

Y is the index of total regional monetary expenditure.

Q is a weighed index that includes all the sectoral effluents of the economy.

α and β are distribution parameters, and $\sigma = 1/(1+\rho)$ is the elasticity of substitution. The environmental quality index (*Q*), is a negative function of the vector of additional pollution flows resulting from the policy or trade shock and is obtained as:

$$Q = 1 - \left[\frac{\sum_i CP_{i,r}}{\sum_i P_{i,r}} \right] \qquad (2)$$

Where CP_{ir} is the additional pollution discharge in a receptor mean *i* in the region *r* and P_{ir} is the baseline total pollution discharge. The additional pollution flows CP_{ir} are obtained from the sum of all the increases of effluents produced by the shock, that is to say:

$$CP_{(i,r)} = \sum_j v_{j,r} \ \ \varepsilon_{i,j,r} \qquad (3)$$

Where $\varepsilon_{i,j,r}$ represents the sectoral effluent intensity[9] *j* in region *r* on the receptor mean *i*. And $v_{j,r}$ is the absolute variation in the output of sector j in region *r*.[10] For a particular

[9] Effluents are measured in kilograms per dollar of economic activity and we assume that pollution is sector specific with constant input-output coefficients.

region (in our case the index r will refer to MERCOSUR), the vector CP_{ir} is then the equivalent of the vector of marginal changes in pollution discharges of the theoretical model ($g_{tp}=-z_p<0$).

C. Environmental preferences and the depth of trade liberalisation.

Given the fairly general welfare evaluation function we defined in the previous section, if trade liberalisation resulted in a degraded environment, would the positive aspiration for a better environment make a more restrictive trade framework more desirable than deep trade liberalisation? Although empirical research cannot provide a general answer to that ambitious question, we can at least obtain some insights on how likely gaining some environmental support for trade liberalisation in MERCOSUR would be.

It is worth mentioning that most of the liberalisation process in the MERCOSUR countries already took place in the baseline year of 1996. As shown in the Figure 3, the important policy reforms that took place between 1989 and 1991 lead to a reduction in import tariffs from an average of 53% to an average as low as 13% in 1995. Strictly speaking we would try to test if it is worth extending the liberalisation process beyond that relatively advanced point.

Table 1 shows the different import tariffs rates in MERCOSUR in 1995 by industry and origin (in the GTAP database). Given the variety of import tariffs, we would need to define an index to measure the deepness of trade liberalisation. In this paper we use a rather intuitive measure consisting in the simultaneous reduction in all the trade distortions by the same percentage rate ($1-\chi$). A restricted liberalisation scenario would imply a reduction of less than 100% of trade barriers. This index may not be representative of the kind of trade policies that governments used to follow, but provides a clear representation of the openness degree of the economy with respect to a baseline scenario.

Figure 3 represents the impact of "trade deepening" over monetary income, environmental quality and the natural resource endowment indexes in MERCOSUR. As

[10] Strictly speaking, in the GTAP terminology, v is the increase in the value of production at market prices *(VOM),* obtained by comparing the pre and post simulation scenario when all the economic adjustments to the new policy or trade environment have taken place. That is to say:

$$v(j,r) = VOM(j,r)_{Post-SIM} - VOM(j,r)_{Pre-SIM}$$

expected, trade tariffs removal results in an increase in market production and regional income. Nevertheless it is worth noting that the maximum income is obtained on the left hand side of the full liberalisation. This is the result of other distortions in the economy (income and factor taxes and subsidies not taken into account in this paper).

Contrary to that positive pattern, in all the liberalisation scenarios trade removal results in a degraded environmental quality (see Figure 3), meaning that pollution of the different sources and different substances increases gradually with tariff removal and that the negative effect of the increased scale of economic activity are not fully compensated by the nevertheless positive effects of the change in the composition of local production.

We are then in the situation described in the theoretical model where the question of whether or not trade liberalisation harms both the environment and welfare becomes a relevant one and when the case may be that a restricted rather than complete liberalisation policy would be preferable (see Figure 1.b above).

The answer to these questions will depend on the relative weight that environmental quality has in regional preferences as expressed in the welfare evaluation utility function. Figure 4 represents the equivalent Hicksian variation for two cases of extreme, but rather plausible, attitudes towards environmental quality. The first is the case where people are only concerned with monetary income whatever the environmental quality impact ($\beta=0$); the corresponding welfare improvement index is represented in the upper solid curve. The second represents a kind of lexicographic ecologic preferences where people are only worried about the environmental impact whatever the income gains at stake in trade openness ($\beta=1$); in that case, as the liberalisation hurts the environment, welfare gains of trade barriers removal are negative as represented in the decreasing curve in the down side of the figure.

We are now ready to answer the critical question of how strong the environmental concern must be in order to prefer a less liberalized economy. This question can be made operational by measuring the critical share of environmental quality changes in the utility function (β^*) that makes the current import tariffs second-best optimal. As suggested by the empirical results displayed in Figure 4 this critical value is as high as

0,93, indicating that the weight of money income changes must be as low as one fifteenth of the environmental pollution weight for people to prefer less trade openness than more in the baseline situation. For parameter β lower than that, liberalisation would improve welfare in spite of the increase in pollution and the degraded environment that go with it.

D. The Case for Pollution Taxes in a non-liberalized economy

The non-liberalisation of the economy may also have important implications on the opportunity cost and the welfare gains that can be obtained by setting an environmental tax to reduce pollution. In contrast with what has been asserted in the introduction about the advantages of trade liberalisation, the double-dividend theory shows that optimal environmental taxes always improve welfare, provided that there is no other distortion in the economy apart from the externality that is being corrected.

As in many others, MERCOSUR economies present many distortionary market interventions that, apart from trade barriers such as quotas, import tariffs export taxes and subsidies, include distortional taxation on capital and labour income. Although the setting of an environmental tax will have the positive effect of reducing pollution it will also lead to an increased opportunity cost of inputs, particularly those produced by heavy polluting industries, and may exacerbate the distortions of trade barriers and taxes.

The general equilibrium model offers a way of testing these effects including all the allocation effects of an environmental tax. To test this, we assume that pollution is sector specific and that, as shown above, emissions of a particular substance are proportional to the activity level of the polluting sector. In this case, the environmental tax can be designed as a product tax. In order to obtain some general and significant results we also group all the most polluting sectors (chemicals and plastics, oil, minerals, metal and electricity) in a single polluting sector in the MERCOSUR area and treat them all as a single sector[11]. We miss out any costs of setting the environmental policy and inspecting the firms and consider that environmental quality degradation

[11] The alternative to obtain the results for single sectors and single contaminants, although practicable, will lead to a wide array of results each leading to not very significative changes in welfare gains. The option of using an aggregate that can be implemented in the context of the GTAP model allows one to obtain some general qualitative conclusions.

only affects welfare as a final consumption good (in the utility function) and not through the reduced productivity of environmental inputs.

The results obtained in the different simulations for monetary income, environment and resource indexes can be seen in Figure 5. As expected, production taxes on the activity of polluting firms reduce market production (*Y*), smoothly reduce pollution (Q_0). The question we would like to pose is in what cases these taxes improve welfare, and if such cases do exist, what the optimal environmental-product tax would be? It is clear that, in any case, environmental taxes reduce market income and, in a balanced economy where there are no production externalities (but only consumption ones), the enforcement of a tax on the production sector would always reduce the monetary value of marketed goods[12].

The reduced value of total production can be interpreted as the general equilibrium cost of improving the environment (and, eventually, saving natural resources). This cost is apparently high in the MERCOSUR economies since a very important share of total output is obtained from these heavily polluting sectors[13]. The following figure represents the welfare index for different assumptions of preferences. The upper curves represent stronger environmental preferences.

What the diagram shows is that preferences for environmental quality need to be relatively strong for any high polluting product tax have a positive welfare impact. In the simulation shown in the figure it will be required that the participation of income in welfare be as low as 3 % (or α lower than 0,03 in the welfare evaluation function).

E. Export taxes instead of environmental taxes.

In the previous section we showed that the general equilibrium opportunity cost of taxing high pollution goods could be so high that, with trade barriers and other distortions existing in MERCOSUR, this policy option may not lead to positive welfare

[12] Our case is then extreme, as we are not for example taking into account the increased productivity of improved irrigation water quality or the higher productivity of cleaner soils. Moreover, this productivity of ecosystems seems to be more important for activities such as agriculture, fishing, or water supply which amount to a low share of the total output. Most of the pollution considered here is discharged into the atmosphere, the quality of which is less important in production.

[13] In MERCOSUR high pollution sectors represent 16,4% of the regional product (in contrast with 11,2% in NAFTA and 12,2% in Europe, and 19,2 in the rest of Latin American countries. The results presented in this section seem to suggest that MERCOSUR countries may be in the transition stage of the environmental Kusnetz curve.

gains (provided we accept that the willingness to pay for a better environmental quality is not high enough to compensate for the market income opportunity cost of setting up these product taxes).

If it is difficult to get social support in favour of environmental taxation, and trade is not liberalised, it is reasonable to think, as the previous results suggest, that export taxes could have positive environmental effects. To test this hypothesis we run a number of simulations of the GTAP-ENV model to compute the effects of changing the current 3% tax on high polluting goods exports over the monetary income, the environment and natural resources. The results can be synthesised in Figure 6.

The figure presents the relation between the utility index and the export tax level. Current export taxes and welfare starting point are represented by the baseline (where the utility index is 1 and the average tax is around 3,2 per-cent). As shown in the figure real income (*Y*) increases with reductions in export taxes on high polluting goods and, when all general equilibrium effects are taken into account, this growth comes with an increase in non-internalised pollution levels (and reduced environmental quality (*Q)).*

Each one of the curves represented in Figure 6 represents the welfare effect of taxing exports of high polluting goods. If people are unaware of environmental quality, welfare decreases with export taxes (as represented by the decreasing line with β=0), and the removal of export taxes will produce a welfare improvement. Nevertheless, as pollution externalities remain, the welfare effect of removing such a trade barrier is less important, when we consider certain positive preferences for environmental quality. In some cases, removing export tax barriers could have a detrimental welfare effect, as it may happen in the model if the share of environmental quality and resource preservation in the utility function is higher than 40% *(β=0,4).* Although in developing economies where externalities are not corrected we can accept that the desire for a better environmental quality may foster arguments in favour of the conservation of trade barriers, the evidence from MERCOSUR suggests that this desire must be fairly strong.

IV. Some conclusions:

The overall environmental impact of trade liberalisation in less developed countries is ambiguous. Whether trade openness damages or eventually improves the environment depends on many factors such as the higher scale of the economy, the resulting change in the composition of local production and the induced effects on technology and institutions that will carry out trade openness. If externalities are not corrected by optimal environmental policies, and trade openness leads to a lower environmental quality it might also reduce welfare. Given the complex nature of this problem, and the absence of a general theory to determine the welfare impact of trade liberalisation in the presence of non-corrected externalities, we presented some empirical experiments derived from the GTAP-ENV general equilibrium model in the MERCOSUR area. If economic theory cannot provide a final answer to what the welfare effect of trade deepening will be, it can at least provide a useful method to identify and compare the many relevant results that can be expected from trade policy over income the environmental quality and resource stocks.

We first showed that the effect of tariff removal is negative on the environmental quality and positive over regional income. The evidence presented seems to suggest that a deeper integration in the world economy would enhance the negative scale over the positive composition effect, leading to a worse environmental quality. Nevertheless, the dismissal of continuing the liberalisation process would only be justified if environmental concerns were overwhelmingly important in people's preferences compared with the relative welfare importance of money income.

The second part of our research showed that in the presence of trade barriers and other distortional taxes, the opportunity cost of taxing high polluting goods (which within the framework of our model is equivalent to taxing pollution) may be substantially higher than the agents' willingness to pay for subsequent environmental improvements. Preferences for environmental quality thus need to be fairly strong for a positive optimal high polluting product tax to exist. Trade and other distortions might then reduce welfare gains from environmental taxes.

Third, if environmental taxes are perceived as costly instruments to improve environmental quality, environmental preferences might act in favour of maintaining some trade barriers (such as exports taxes). As opposite to pollution taxes, trade barriers are part of the *status quo*, easy to implement, and, in the case of export taxes, have a certain noticeable positive impact on the environment. Nevertheless, for this to be second best efficient, the marginal willingness to pay for environmental quality must be implausibly high.

It is hard to draw general conclusions from empirical research but this evidence could actually shed some light on the clarification of the complex links between trade and the environment. Finally, as Woodrow Wilson stated “we shall deal with our economic system as it is and as it may be modified, not as it may be if we had a clean sheet of paper to write upon; and step by step we shall make it what it should be” (quoted by Schöb, 1996)

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Appendix A
Derivation of the Second Best General Equilibrium Balance Condition[14]

Starting from the general first best condition:

$$e_u du \equiv r' dm + (t' - e_z) dz \qquad (5)$$

That can be expressed as:

$$e_u du \equiv (r', t' - e_z)\begin{pmatrix} dm \\ dz \end{pmatrix} \qquad (1.A)$$

Our purpose is to replace the endogenous marginal response in imports and pollution, represented by the differentials *dm* and *dz*, by representing them as the optimal response of the economy to marginal change in trade and environmental policy instruments (or, of both differentials *dr=dp* and *dt*).

- As a first step we can recall that the vector (*m, z*), of net imports and pollution, can be represented as:

$$\begin{pmatrix} m \\ z \end{pmatrix} = \begin{pmatrix} E_p(\pi, z, u) \\ E_t(\pi, z, u) \end{pmatrix} = \begin{pmatrix} E_p(\pi, g_t(p,t), u) = e_p(p,z,u) - g_p(p,t) \\ g_t(\pi) \end{pmatrix} \qquad (2.A)$$

- Totally differentiating the previous expression, we obtain:

$$\begin{pmatrix} dm \\ dz \end{pmatrix} = \begin{pmatrix} E_{p\pi} d\pi + E_{pz} E_{t\pi} d\pi + E_{pu} du \\ E_{t\pi} d\pi \end{pmatrix} = \begin{pmatrix} I & e_{pz} \\ 0 & I \end{pmatrix} \begin{pmatrix} e_{pp} - g_{pp} & -g_{pt} \\ -g_{tp} & -g_{tt} \end{pmatrix} \begin{pmatrix} dp \\ dt \end{pmatrix} + \begin{pmatrix} X_I \\ 0 \end{pmatrix} e_u du$$

(3.A)

- We can define the matrix:

$$E_{\pi\pi} = \begin{pmatrix} e_{pp} - g_{pp} & -g_{pt} \\ -g_{tp} & -g_{tt} \end{pmatrix} \qquad (4.A)$$

As the second derivatives of imports and pollution, to changes in both prices (*p*) and taxes (*t*).

- And, after replacing it in (3.A) and then in (1.A), we obtain:

$$e_u du \equiv (r', r' e_{pz} + t' - e_z) E_{\pi\pi} \begin{pmatrix} dr \\ dt \end{pmatrix} + (r', t - e_z) \begin{pmatrix} X_I \\ 0 \end{pmatrix} e_u du \qquad (5.A)$$

- That can be simplified as:

$$(1 - rX_I) e_u du \equiv (r', r' e_{pz} + t' - e_z) E_{\pi\pi} \begin{pmatrix} dr \\ dt \end{pmatrix} \qquad (6.A)$$

Which is the expression (6) in the main text.

- If environmental taxes are institutionally fixed (then *dt=0*), we can use (4.A) and solve (6.A) as:

$$(1 - rX_I) e_u du \equiv (r', r' e_{pz} + t' - e_z) \begin{pmatrix} e_{pp} - g_{pp} \\ -g_{tp} \end{pmatrix} dr \qquad (7.A)$$

[14] See Neary (2000)

Or:

$$(1-rX_I)e_u du \equiv (r'(E_{pp}) - (r'e_{pz} + t' - e_z)g_{tp})dr \qquad (8.A)$$

From which it is easy to obtain the second-best optimal tariff, as appear in expression (7) in the paper.

Appendix B: Main Components and Notation of the GTAP-ENV Model

I. ECONOMIC SECTORS AND AGGREGATED COMMODITIES (GTAP V.4.0)

Agric: Paddy rice, wheat, cereal grains, vegetables, fruit, nuts, oil seeds, sugar cane, sugar beet, plant-based fibbers, crops, bovine cattle, sheep and goats, horses, wool silk-worm cocoons, fishing, bovine cattle, sheep and goat, horse meat prods.
Wood: Forestry, wood products.
Petrol: Coal, oil, gas.
Food: Raw milk, meat products, vegetable oils and fats, dairy products, processed rice, sugar, food products, beverages and tobacco products.
Text: Textiles
Paper: Paper products, publishing
Petrol: Petroleum, coal products.
Chepla: Chemical, rubber, plastic products.
***Mineral**:* Minerals, mineral products.
Metal: Ferrous metals, metals and metal products.
Othmn: Animal products, wearing apparel, leather products, electronic equipment, machinery and equipment, manufactures, motor vehicles and parts.
Elec: Electricity
Serv: Gas manufacture, distribution, water, construction, trade, transport, business, recreational services, public administration and defence, education, health, dwellings

II. REGIONAL AGGREGATION (GTAP V.4.0)

NAF: Canada, United States of America, Mexico
CLA: Venezuela, Colombia, Rest of Andean Pact, Chile, Rest of South America
MERC: Argentina, Brasil, Uruguay.
EU: United Kingdom, Germany, Denmark, Sweden, Finland and Rest of European Union.
ROW: Rest of World

III. AGGREGATED ENDOWMENTS (GTAP V.4.0)

Land: Land (sluggish)
Lab: Labour (mobile)
Capital: Capital (mobile)
NatRes: Natural resources (partial sluggish)

IV. AGGREGATED POLLUTION EMISSIONS (IPPS)

IPPS is a modelling system, which combines data from industrial activity (such as production and employment) with data on pollution emissions to calculate *pollution intensity* factors, i.e. the level of pollution emissions per unit of industrial activity. The pollutants included are:

Toxic Pollutants by mean
Toxic Chemicals (Toxair, Toxwat, Toxland)
Bio accumulative Metals (Metair, Metland, Metwat)

Air Pollutants
Total Suspended Particulates (TP)
Sulphur Dioxide (SO2
Nitrogen Oxides (NOX)

Carbon Monoxide (CO)
Volatile Organic Compounds (VOC)

Water Pollutants
Biological Oxygen Demand (BOD)
Suspended Solids (TSS)

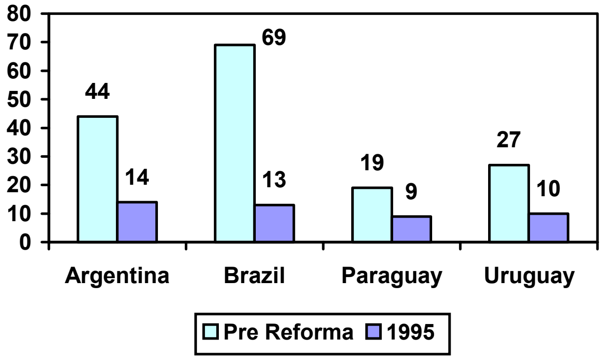
V. SOLUTION METHOD (Gempack 6.0)
Method = Gragg;
Steps = 2 4 6;

VI. CLOUSURE GTAP-ENV MODEL (Gempack 6.0)
Standard Multiregional General Equilibrium closure
psave varies by region, pfactwld is numeraire
Exogenous
 pop
 psaveslack pfactwld
 profitslack incomeslack endwslack
 cgdslack saveslack govslack tradslack
 ao af afe ava atr
 to txs tms tx tm
 qo(ENDW_COMM,REG) ;
Rest Endogenous.

V. APPLIED SCENARIOS IN GENERAL EQUILIBRIUM (Gempack 6.0)
1. IMPORT TARIFFS REMOVAL
Consists on a the reduction of al tariffs af MERCOSUR import commodities from any origin in the same percentage rate.
2. PRODUCTION TAX ON POLLUTION SECTOR:
Consists of setting up a tax over the production of the pollutant sector (from 0 to 20%) in the region of MERCOSUR.
3. EXPORT TAX ON POLLUTION SECTOR:
Consist of setting up an export tax over high polluting goods (ranging from 0 to 20%) in the region of MERCOSUR.

Figure 2

Average Import Tariffs in MERCOSUR Countries



Source: IBD (1996)
Note: Trade reforms took place in Argentina in 1989; Brazil in. 1990; Paraguay in 1989 and Uruguay in 1991.

Figure 3

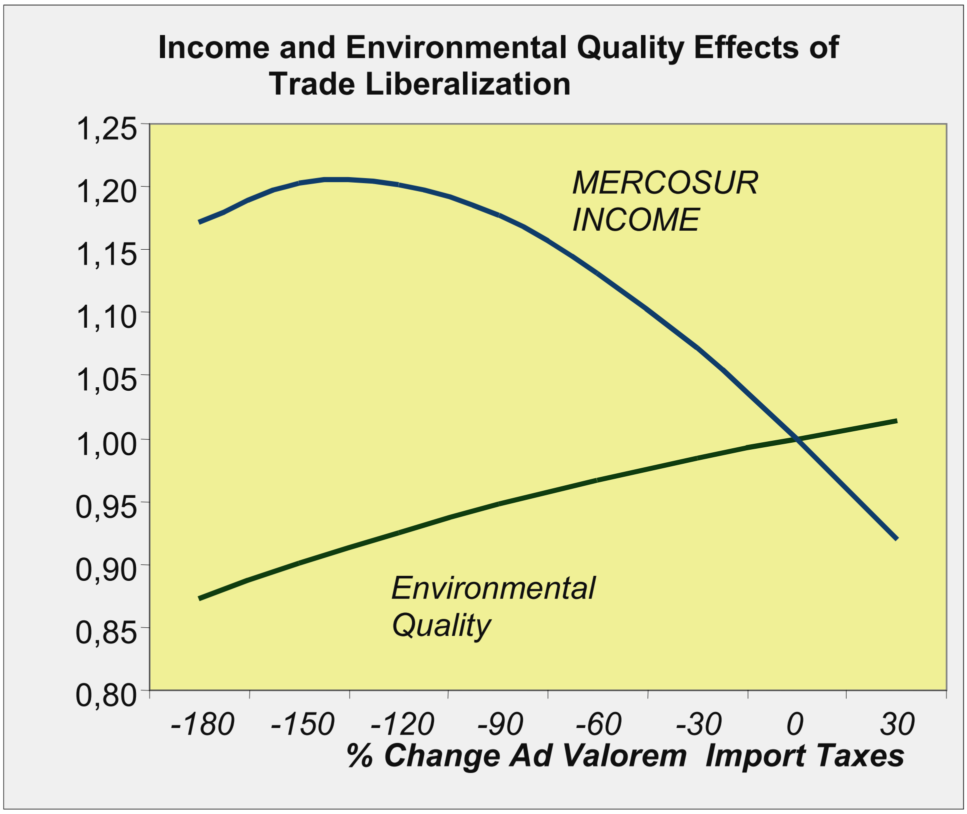


TABLE 1: **Import Tariffs in MERCOSUR by Origin in Baseline (1996)**

	Rest of the World	NAFTA	MERCOSUR	Rest of Latin America	European Union
1 agriculture	7,2	6,8	9	7,7	5,3
2 food	0,9	5,5	0	9,7	4
3 textiles	16,1	11,5	12,1	8,2	15,6
4 wood	10,8	10,2	12,9	9,4	11,4
5 paper	7,7	3,3	9,5	3,9	8
6 chem. and Plastics	7,6	8,8	10,6	12	9,1
7 petrol	16,5	8,6	15,3	17,4	8,9
8 mineral	6,6	5,7	8,1	1	9,2
9 metal	12,2	12	12,5	6,6	12,5
10 elect.	0	0	0	0	0
11 other manuf.	17,9	17,5	17,4	16	17,7
12 serv	1,3	1,2	1,1	0,1	1,8

Figure 4

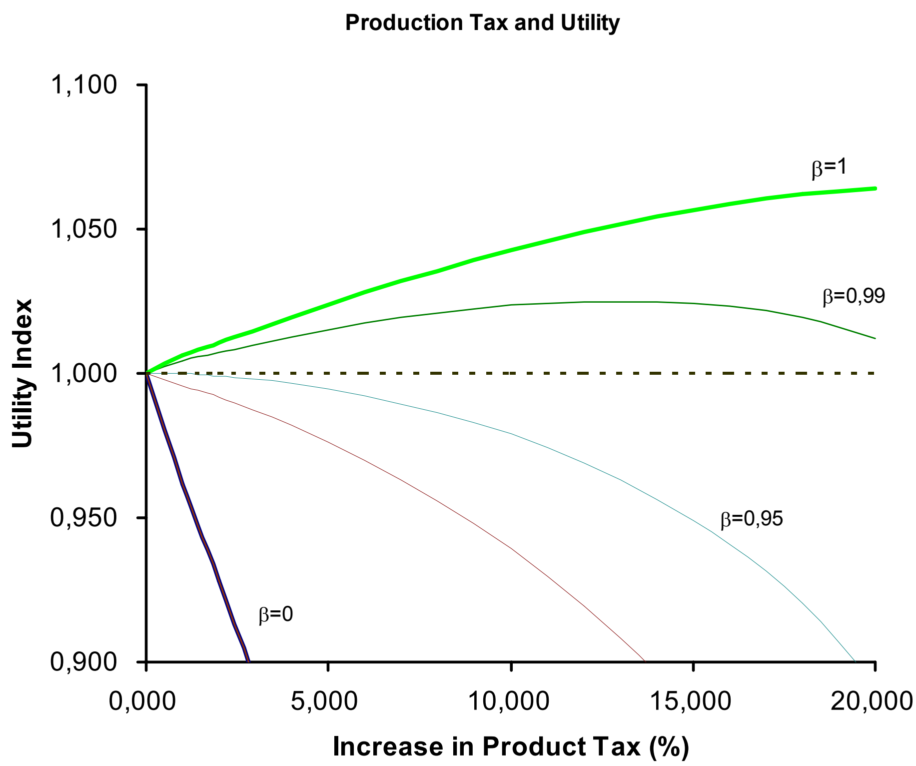


Figure 5