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Protection by Tariff Barriers and International Transport Costs

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Abstract

Using estimates of protection in the EU market against US exports, this paper illustrates the relative importance of natural and policy sources of protection and the measurement errors induced in the measurement of effective protection by omitting transactions costs. It also considers protection in the EU 'domestic' and export market, and the implications of the elimination of tariff barriers only on relative rates of protection in 'domestic' and export markets.

Outline

1. Introduction
2. Trade barriers: tariffs and transaction costs compared.
3. A simple model of effective protection.
4. Effective protection in the EU market.
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6. Effective protection in EU-US trade and trade regime bias.
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Non-Technical Summary

Most work on the nature and extent of barriers to international trade concentrates on policy barriers, in particular tariffs and non-tariff border interventions by policy makers. These barriers are now low or have been eliminated completely by regional (e.g. EU) and multilateral agreements (GATT 'rounds'), and will decline further as current and future commitments are implemented. Since these declines in policy barriers are often viewed by trade economists as major contributory factors in the growth in world trade, then one might anticipate that the scope for further growth in world trade is restricted. But this interpretation of trade prospects fails to take appropriate account of another important source of trade barrier, namely so-called "natural" barriers associated with the costs of transacting internationally. An important element of these is the cost of transporting goods internationally, by land, air or sea. Ironically it is often popularly believed that technological improvements in the transportation sector (e.g. containerisation) have substantially reduced the cost of transacting internationally, and may therefore have been at least as important as policy liberalisation in stimulating the growth of world trade. However, recent work, including this paper, challenges the view that 'natural' barriers have fallen significantly. Indeed, the paper shows that transport costs now in general pose a markedly greater barrier to trade than tariffs. In nominal terms the simple average EU tariff on manufactured imports from the US is less than 5% (and will fall further once all the Uruguay Round Commitments are implemented), while the average rate of international transportation cost (i.e. nominal 'protection' rate) on these same imports is 8%. The divergences between the nominal protection rates between policy and natural barriers are of course even greater than this in some manufacturing sectors. More importantly both of these barriers apply on both competing final imports and on intermediate importable imports. In which case there are likely to marked differences between the effective rates of protection arising from policy barriers alone and those arising from policy and natural barriers combined. The paper illustrates these differences with estimates of effective rates of protection for EU manufacturing sectors for each source of barrier and when combined. It is clear that measuring effective protection for policy barriers alone is in general misleading; giving rise to measurement errors and to misrepresentation of the relative pattern of incentives to produce for local as opposed to export markets. Where tools of analysis such as effective protection are used to comment on trade issues they should not, as they often do, omit natural barriers. There may be considerable scope for promoting world trade by lowering 'natural' barriers.

1. Introduction

There is a large empirical literature on the measurement of effective protection.[1] Most recent work has been inspired by pressures for trade liberalisation, and the resulting desire to measure pre-reform and post-reform protection.[2] The focus has been almost exclusively on policy induced rather than natural barriers to trade.[3] But the low level of policy barriers in many industrialised countries may now mean that transactions costs are likely to be at least as important as trade policy–induced price effects. Moreover, implementation of Uruguay Round tariff reductions and commitments to further liberalisation will only intensify this.

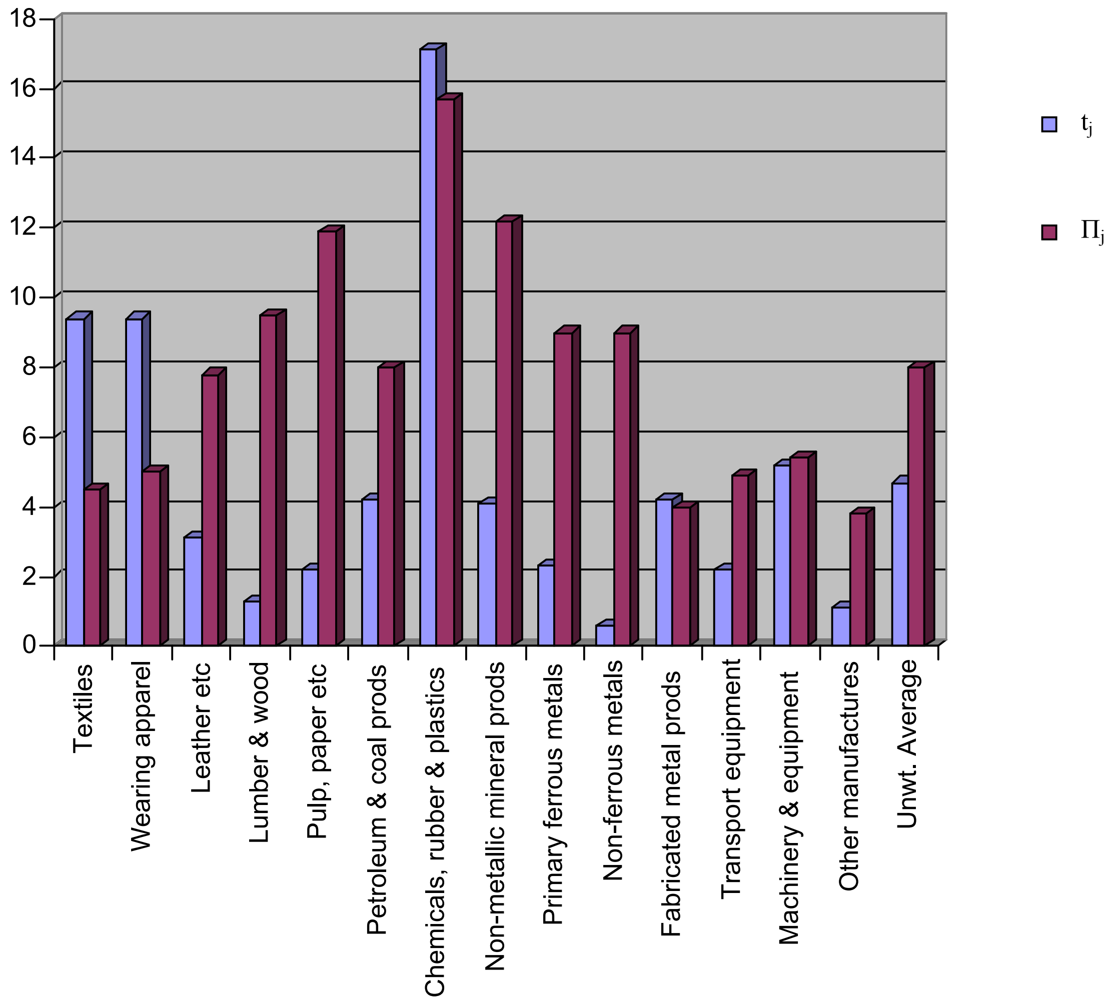
The purpose of this paper twofold: first to compare the relative magnitudes of natural and policy based sources of effective protection; second, to estimate the potential measurement error induced when natural barriers are ignored. Our focus is protection against US export into the EU.

The remainder of the paper is organised as follows. Section 2 reviews the prevailing evidence on the relative importance of trade policy and natural barriers. Section 3 sets up a simple model of effective protection in the home market which allows for both policy and natural barriers and identifies sources of measurement error associated with a model that omits the latter. Relative magnitudes of natural and policy barriers and potential measurement error associated with exclusion of natural barriers are illustrated in Section 4, with evidence for EU protection against manufactured imports from the US. The analysis is extended in Section 5 to allow for export sales, and the comparison of relative protection in home and export markets. Section 6 reports on estimation of relative rates of protection in EU and export markets in competition with US producers, and on the implications of a zero tariff option being implemented. Finally the conclusions and implications of the analysis are set out in Section 7.

2. Trade barriers: tariffs and transaction costs compared

It has often been argued in the popular press that technological improvements in the transportation sector have reduced international transaction costs substantially, and have been a major factor in the growth in world trade post-world war II.[4] Trade economists by contrast have often attached considerable importance directly to bilateral and multilateral policy reforms in explaining world trade growth. More recent evidence on both the extent of non-trade policy barriers and their impact on trade volumes is producing a reassessment of these views. This is in part the indirect consequence of the effects of policy liberalisations on artificial trade barriers and therefore on the relative importance of 'natural' barriers. It is however evident also that the reduction in 'natural' international transaction costs, in particular transport costs, has been overstated. Hummels (1999a) for instance draws together various sources of data on the time-series pattern of shipping costs to show that, while air freight rates have fallen, ocean freight rates an average (despite

Figure 1Relative Rates of Nominal Tariff (t_j) and 'Natural' (Π_j) Protection



Source: estimated from Hertel (1997)

containerisation) have actually increased until quite recently. In line in fact with earlier studies cited above (see fn3), Hummels concludes that transport costs still often pose a greater barrier to trade than tariffs. Indeed, transport costs tend to vary more across trading

partners than tariff rates, implying a greater role for 'natural' than artificial barriers in fashioning variation in bilateral trade flows. Hummels (1999b) for example reports (unweighted) mean freight rates for the US in 1994 of between 12 and 15 percent advalorem; where these rates only capture the inter-country component and omit port and inland charges. He further shows that freight rates were substantially higher than tariff rates in the US for most manufactured goods.

The primary purpose of the present paper is to explore the implications of omitting 'natural' barriers from the measurement of protection, rather than provide precise and comprehensive measures of different types of and of total levels of 'natural' protection. It is clear however, from the information in figure 1, that the evidence for the EU is in line with that identified by other authors for the US; for 10 of the 16 manufacturing sectors the nominal rate of natural protection exceeds the average (nominal) tariff for that sector. (The nature and source of this information is discussed in section 4.)

3. A simple model of effective protection

Take a small country and homogenous good, where the cost of any barrier is borne wholly by the importing country. The final good j uses a fixed technology of v units of a single, intermediate importable good i, where the world prices of each are respectively P_j and P_i. Thus the value share (a_{ij}) of i in the production of j at world prices is:

$$a_{ij} = \frac{v.P_i}{P_j} \qquad (0 < a_{ij} < 1) \qquad (1)$$

The introduction of a tariff (t_j) and transaction frictions to trade means that the technological coefficient at actual distorted prices (a'_{ij}) can be written as:

$$a'_{ij} = \frac{v.P_i \ [1+t_i] \ [1+\Pi_i]}{P_j \ [1+t_j] \ [1+\Pi_j]} \tag{2}$$

where t_m = ad valorem tariff on c.i.f. value of imports competing with m $[m = i, j]$

and Π_m = constant, ad valorem – equivalent rate of transaction cost on value of import m $[m = i, j]$

Implicit in the representation in (2) is the assumption that domestic producers of both j (and i if there is local production of the intermediate) price fully up to the levels permitted by nominal protection ($t_m + \Pi_m + \Pi_m t_m$, where m = j,i).[5]

The frictionless technological coefficient has therefore to be estimated $(\hat{a}_{ij})$ from the observed, distorted coefficient as follows:

$$\hat{a}_{ij} = \frac{a'_{ij} \ [1+t_j] \ [1+\Pi_j]}{[1+t_i] \ [1+\Pi_i]} \tag{3}$$

Thus $\hat{a}_{ij} \gtrless a'_{ij}$ as $(1+t_j+\Pi_j+t_j\Pi_j) \gtrless (1+t_i+\Pi_i+t_i\Pi_i)$.

With escalation of nominal protection rates, actual technological coefficients understate true frictionless technological coefficients. Note from [3] that if we abstract from natural barriers or do not have information on them, then adjusting the distorted technological coefficients for policy barriers only will give an accurate estimate of a'_{ij} only if $\Pi_j \doteq \Pi_i$ i.e. if the implicit rate of protection from transaction costs is approximately the same for intermediate and final goods. Even in the present case when both i and j are importables, there may be reasons why $\Pi_j \neq \Pi_i$. The nature (weight, fragility and so on), origin, mode of transport and scale of trade may be different for a final product and its intermediate inputs.

Consider now the measurement of effective protection (e_j), which is defined as:

$$e_j = \frac{V_j^{/} - V_j}{V_j}$$

where V_j = value added in activity j or net price of final product j at frictionless world prices

$V_j^{/}$ = value added in activity j at distorted domestic prices

In the single input case, maintaining our earlier assumptions, then:

$$V_j = P_j - vP_i = P_j - a_{ij} P_j \qquad (5)$$

$$V_j^{/} = P_j (1 + t_j)(1 + \Pi_j) - a_{ij} P_j (1 + t_i)(1 + \Pi_i) \qquad (6)$$

Substituting (5) and (6) into (4) and reducing gives us the following expression for the effective rate of protection for import competing production of j:

$$e_j = \frac{(t_j + \Pi_j + \Pi_j t_j) - a_{ij}(t_i + \Pi_i + \Pi_i t_i)}{1 - a_{ij}} \qquad (7)$$

Thus there are three broad sources of potential measurement error associated with the estimation of effective rates of protection; error in measuring nominal output protection $(t_j + \Pi_j + \Pi_j t_j)$, error in measuring input taxation $(t_i + \Pi_i + \Pi_i t_i)$ and error in estimating the technical coefficient (a_{ij}).

If we rewrite eq. (7) as:

$$e_j = e_j^P + e_j^N + e_j^I$$

where $e_j^P = \left[\dfrac{t_j - a_{ij}t_i}{1-a_{ij}}\right]$, $e_j^N = \left[\dfrac{\Pi_j - a_{ij}\Pi_i}{1-a_{ij}}\right]$, and $e_j^I = \left[\dfrac{\Pi_j t_j - a_{ij}\Pi_i t_i}{1-a_{ij}}\right]$ (8)

we can conceive of three components of the complete measure of effective protection, namely a policy protection only component (e_j^P), a natural protection only component (e_j^N) and an interactive policy/natural protection component (e_j^I). In which case the measurement error $(e_j - e_j^*)$ induced by the inappropriate assumption that $\Pi_i = \Pi_j = 0$ is composed of three elements as follows:

$$(e_j - e_j^*) = \Delta e_j^P + e_j^N + e_j^I \tag{9}$$

where e_j^* = distorted measure of effective protection

Δe_j^p = distortion in the measurement of policy protection due to the use of distorted estimates of the technological coefficients and e_j^N and e_j^I as defined above.

Almost all existing empirical work ignores natural barriers and estimates e_j^*, implicitly setting $\Pi_i = \Pi_j = 0$. To the extent that the focus is on policy sources of protection and the effects of trade policy reform, then a preoccupation with measurement of the policy component only is understandable. However this requires us to ignore the interactive effects of policy and natural barriers i.e. to ignore the terms $\Pi_j t_j$ and $\Pi_i t_i$ in eq.(7). It is also to note important that the technical coefficients (a_{ij}) may be mis-estimated if $\Pi_j \neq \Pi_i \neq 0$.[6]

4. Effective protection in the EU Market

To illustrate the measurement error associated with omitting natural barriers from the calculation of effective protection we take the case of barriers facing US manufactured exports into EU markets. Estimates of policy and natural barriers are taken from the GTAP database (Hertel, 1997) for fourteen manufacturing sectors.[7] The technological coefficients are also taken from the same source.[8] This base data which is set out in Table 1 shows, as expected, relatively low levels of policy induced nominal protection - the weighted average being below 10% in all sectors but 'chemicals, rubber and plastics'.[9] More surprising is the mixed pattern of both tariff escalation and de-escalation. Average tariffs on intermediates (t_i) are measured by the trade weighted average tariff on intermediate imports of each sector from all sources. [10] Nominal transaction cost rates (Π_j and Π_i) are generally higher than nominal policy barriers; the unweighted average across sectors being about 8% and 8.6% respectively. Indeed Π_j is greater than t_j in ten of the fourteen sectors. The similarity of implicit taxation of outputs and inputs from natural barriers means that on average there is unlikely to be a significant distortion of technological coefficients from this source, though this is affected by the relatively high level of aggregation. At a more disaggregated, industry level one would anticipate greater variation in the Π_j and Π_i rates and therefore greater variation in the divergence between Π_j and Π_i rates.

Overall rates of effective protection (e_j), corresponding to the nominal data in Table 1 and estimated using (7), are reported in table 2. The unweighted average across sectors is 10.4%, with a range of –2.7% to +22%. By contrast the distorted (e_j^*) or policy-only measure (where Π_j and Π_i are incorrectly assumed to be zero) has an average value of only 2.6%, and range of –5.8% to +19.7%. The ranking of specific industries is also affected in a non-trivial manner in the move from the policy-only to the total measure of effective protection. Textiles and fabricated metal products for example both fall six places in the rank order, as their relative level of measured effective protection falls. The absolute divergences are also quite marked, and this is no doubt of relevance to both the specific sector and to those negotiating trade reforms relating to that sector. In the case of 'chemicals, rubber and plastics' for instance the distorted, policy-only measure is over 23 percentage points less than the complete measure. Indeed there are four sectors where the distorted measure is at least 10 percentage points too small, while there are two sectors 'fabricated metal products' and 'other manufactures' where the complete measure falls in absolute terms relative to the distorted measure.

Table 1 Base data on nominal protection

Sector	t_j	Π_j	t_j	Π_i	$a_{ij}^{/}$
Textiles	0.094	0.045	0.173	0.079	0.386
Wearing apparel	0.094	0.050	0.118	0.064	0.388
Leather etc	0.031	0.078	0.159	0.092	0.409
Lumber & wood	0.013	0.095	0.045	0.090	0.386
Pulp, paper etc	0.022	0.119	0.059	0.113	0.385
Petroleum & coal prods	0.042	0.080	0.018	0.051	0.546
Chemicals, rubber & plastics	0.171	0.157	0.120	0.129	0.337
Non-metallic mineral prods	0.041	0.122	0.053	0.091	0.464
Primary ferrous metals	0.023	0.090	0.046	0.088	0.462
Non-ferrous metals	0.006	0.090	0.046	0.088	0.464
Fabricated metal prods	0.042	0.040	0.047	0.088	0.465
Transport equipment	0.022	0.049	0.075	0.064	0.421
Machinery & equipment	0.052	0.054	0.077	0.063	0.457
Other manufactures	0.011	0.038	0.052	0.100	0.380
Unwt. Average	0.047	0.080	0.078	0.086	0.425

Finally in table 2 we report on the decomposition of the measured distortion indicated by (9). The natural protection-only component (e_j^N) is consistently the major source of the distortion. Given the similarity between output and input transaction cost rates (Π_j and Π_i respectively) at this high level of aggregation, there is little distortion (Δe_j^P) due to mis-estimation of 'frictionless' technical coefficients. Similarly the interaction term effect (e_j^I) is restricted by the low levels of nominal policy protection. Again these effects may become more important with greater disaggregation, as they are for those countries (especially developing countries) where nominal protection levels are considerably higher.

Table 2 Potential measurement error and its decomposition

	Distorted Measure	Complete Measure	Measurement Error	Decomposition		
	e_j^*	e_j	$(e_j - e_j^*)$	Δe_j^P	e_j^N	e_j^I
Textiles	0.044	0.060	0.015	-0.004	0.022	-0.002
Wearing apparel	0.079	0.118	0.040	-0.002	0.040	0.003
Leather etc	-0.058	-0.004	0.054	-0.007	0.068	-0.007
Lumber & wood	-0.007	0.086	0.093	-0.006	0.100	-0.001
Pulp, paper etc	-0.001	0.114	0.115	-0.009	0.125	-0.001
Petroleum & coal prods	0.071	0.220	0.149	0.013	0.129	0.008
Chemicals, rubber & plastics	0.197	0.431	0.234	0.018	0.180	0.036
Non-metallic mineral prods	0.031	0.193	0.162	-0.005	0.162	0.005
Primary ferrous metals	0.003	0.088	0.084	-0.007	0.091	0.000
Non-ferrous metals	-0.029	0.068	0.096	-0.011	0.111	-0.003
Fabricated metal prods	0.038	0.023	-0.015	-0.001	-0.013	-0.001
Transport equipment	-0.016	0.014	0.031	-0.004	0.037	-0.002
Machinery & equipment	0.031	0.073	0.042	-0.004	0.045	0.001
Other manufactures	-0.014	-0.027	-0.013	-0.004	-0.006	-0.003
Unwt. Average	0.026	0.104	0.078	-0.002	0.078	0.002

5. Extending the analysis to allow for exports

The model set out in Section 2 can be viewed either as representing the importables only case (all sales of a product going to the home market) or as providing a measure of protection in the home market only where the product is exportable. In practice, in multi-product sectors with sales in both home and export markets, the average rate of effective protection $(\bar{e}_j)$ will be a weighted average of protection in home sales in competition with imports (e_m) and in export sales (e_x)

$$\text{ie } \hat{e}_j = w_m e_m + (1 - w_m)\ e_x \qquad (10)$$

where w_m = share of domestic sales in total sales

The term e_m is calculated using equation 7; policy and natural barriers or competing final imports tending to increase effective protection in domestic sales, with policy and natural barriers against importable intermediate imports tending to reduce effective protection. Effective protection in export sales is not however appropriately represented by (7). Tariffs (or any policy barrier against final imports) do not protect production destined for export markets, ie the terms t_j and $\Pi_j t_j$ are unambiguously zero. Natural barriers affect importation and exportation however. Although the incidence of the barrier or implicit tax between producers and consumers may differ between the importables and exportables case, we assume here that the tax is born by exporters.[11] We need to reverse the sign on Π_j; natural barriers disprotecting export sales. On the input side by contrast there is no asymmetry between an importables and exportables model; both trade policy (in the absence of duty drawback or exemption) and natural barriers raise the price of importable intermediates and tend to disprotect final producers of importables and exportables. The extended (policy and natural barrier inclusive) model of effective protection for export sales is therefore given by:

$$e_x = \frac{-\Pi_j - a_{ij}(t_i + \Pi_i + \Pi_i t_i)}{1 - a_{ij}} \qquad (11)$$

In the case of effective protection for importables (eg 7) the level and sign of e_m is ambiguous; $e_m \gtrless 0$ as $(t_j + \Pi_j + \Pi_j t_j) \gtrless (t_i + \Pi_i + \Pi_i t_i)$. With any tendency towards tariff escalation $(t_j > t_i)$ and similar nominal rates of transaction costs on imports and exports however, e_m will tend to be positive and higher than normal protection levels. (The evidence for the EU in the previous section is consistent with this). For exportables there is no ambiguity; $e_x < 0$ for any (positive) values of Π_j, Π_i and t_i.[12] Exports are taxed by both policy and natural barriers. Note also that e_x is still negative under the free trade case where $t_i = 0$; and that the differential (or trade regime bias) between the effective protection rates for importables and exportables in a sector $(e_m - e_x)$ is only lowered by policy reform if tariffs on final goods are lowered. In other words:

$$\frac{\partial e_m}{\partial t_i} = \frac{\partial e_x}{\partial t_i} = \frac{-a_{ij}}{1-a_{ij}} < 0,$$

while $$\frac{\partial e_m}{\partial t_j} = \frac{1}{1-a_{ij}} > 0$$

and $$\frac{\partial e_x}{\partial t_j} = 0\,.$$

Finally we should note that the effective rate of protection in export sales can be decomposed as before, such that

$$e_x^P = \frac{-a_{ij} t_i}{1-a_{ij}} \tag{12a}$$

$$e_x^N = \frac{-\Pi_j - a_{ij}\Pi_i}{1-a_{ij}} \tag{12b}$$

and $$e_x^I = \frac{-\Pi_i t_i}{1-a_{ij}} \tag{12c}$$

6. Effective protection in EU-US trade and trade regime bias

Section 3 has already reported on levels of effective protection in the EU market against US imports. Table 3 includes the results from table 2, but this time identifies also the component of protection due to policy barriers $\left(e_m^P\right)$. The picture that emerges here is of generally modest positive levels of overall effective protection in the EU market (10.4% average across sectors), with about three quarters of this being accounted for by natural barriers. Indeed policy induces higher effective protection in only two sectors (chemicals, fabricated metal products), and $\left(e_m^P\right)$ is negative in half of them. In line with other studies of effective protection and even in a developed country context, marked variability in effective protection is induced by non-uniform nominal taxation of imported final goods and intermediate imports. Here we show however that natural barriers tend to be more important in providing a net implicit subsidy to producing for the 'local' market.

The results for effective protection of EU export sales to the US $\left(e_x\right)$ display both similarities and dissimilarities with the estimates for $\left(e_m\right)$. Again natural barriers are the major influence, accounting for about 75% on average of the overall net 'taxing' effect of policy and natural barriers on exporting; the average rate of disprotection being 32.1%. In absolute terms however policy and natural barriers are more important on the export than the importables side. It is in fact natural barriers that account for this absolutely larger effect. Whereas a natural barrier acts as a tax on inputs for both importables and exportables production, in the case of the production of final goods there is a clear asymmetry - an implicit subsidy effect for importables and implicit tax effect for exportables. Thus the average rate of e_m^N is +7.8%, but for e_x^N it is over three times higher in absolute terms at – 24.1%.

The consistent 'taxing' effect of policy and natural barriers is evident in the estimates in Table 3. Both e_x^N and e_x^P are negative in every sector. Since tariffs on final goods can only 'subsidise' importables production, then e_x^P can only be zero or negative. Given positive nominal import tariffs, the sectoral rates are shown to range from –11.9% (leather etc) to -3.1% (petroleum and coal products) and to average – 6.8%. Since natural barriers against imports into exports on final exports cannot be avoided, e_x^N can only be negative. The results confirm this; ranging from – 40.1% in (chemicals) to –13.1% in (textiles).

Table 3 Effective protection in EU-US Trade and its decomposition

	EU Market				Export Market			
Sector	Components			Total	Components			Total
	e_n^P	e_m^N	e_m^I	e_m	e_x^P	e_x^N	e_x^I	e_x
Textiles	0.04	0.022	-0.002	0.060	-0.118	-0.131	-0.023	-0.272
Wearing apparel	0.076	0.040	0.003	0.118	-0.087	-0.134	-0.013	-0.234
Leather etc	-0.065	0.068	-0.007	-0.004	-0.119	-0.205	-0.026	-0.350
Lumber & Wood	-0.013	0.100	-0.001	0.086	-0.036	-0.245	-0.007	-0.288
Pulp, paper etc	-0.010	0.125	-0.001	0.114	-0.051	-0.318	-0.012	-0.382
Petroleum & coal prods	0.084	0.129	0.008	0.220	-0.031	-0.307	-0.003	-0.341
Chemicals, rubber & plastics	0.214	0.180	0.036	0.431	-0.103	-0.401	-0.029	-0.532
Non-metallic mineral prods	0.026	0.162	0.005	0.193	-0.068	-0.396	-0.011	-0.475
Primary ferrous metals	-0.003	0.091	0.000	0.088	-0.053	-0.296	-0.009	-0.358
Non—ferrous metals	-0.040	0.111	-0.003	0.068	-0.053	-0.314	-0.009	-0.375
Fabricated metal prods	0.037	-0.013	-0.001	0.023	-0.052	-0.181	-0.009	-0.242
Transport equipment	-0.020	0.037	-0.002	0.014	-0.060	-0.140	-0.009	-0.208
Machinery & equipment	0.026	0.045	0.001	0.073	-0.078	-0.172	-0.010	-0.260
Other manufacturers	-0.018	-0.006	-0.003	-0.027	-0.037	-0.137	-0.009	-0.183
Unwt. Average	0.024	0.078	0.002	0.104	-0.068	-0.241	-0.013	-0.321

These results are not intended to be point estimates of the resource allocation effects between sectors, given their partial equilibrium basis. The existing literature on the ranking of partial equilibrium estimates and sectoral resource allocation effects gives mixed results. The key point from the results is the potential incentive biases and corresponding intrasectoral resource pulls away from exportables towards importables. One possible means of summarising this trade regime bias is to measure the differential between effective rates of protection in the EU market and in the export market. For EU-US trade this differential $(e_m - e_x)$ is set out by sector in Table 4. Currently it is 42.5%, and ranges from 15.6% (other manufacturers) to 96.3% (chemicals etc). There is clearly an opportunity to promote extra-EU exports by reducing this anti-export bias induced by natural and policy barriers. Indeed the bias is now presumably lower than it has been in the past, because GATT Rounds have progressively brought down policy barriers over the last forty years. Our estimates suggest however that the scope for further lowering the bias through tariff liberalisation is limited. Table 4 recalculates the $(e_m - e_x)$ differential on the assumption that only the current natural barriers prevailed ie $e_m - e_x = e_m^N - e_x^N$. This is equivalent to considering a future tariff negotiation that resulted in the elimination of EU tariffs. Although the differential or trade regime bias measure falls consistently (with the average falling from 42.5% to 31.9%), it remains relatively large. In other words it is natural, rather than policy, barriers that are the major, current source of bias against extra-regional exports by the EU.

Table 4 Trade regime bias under current and zero tariff conditions

Sector	Current $\left(e_m - e_x\right)$	Zero tariff case $\left(e_m^N - e_x^N\right)$
Textiles	+0.332	+0.153
Wearing apparel	+0.352	+0.173
Leather etc	+0.346	+0.272
Lumber & wood	+0.374	+0.344
Pulp, paper etc	+0.495	+0.443
Petroleum & coal prods	+0.562	+0.437
Chemicals, rubber & plastics	+0.963	+0.581
Non-metallic mineral prods	+0.668	+0.558
Primary ferrous metals	+0.445	+0.387
Non-ferrous metals	+0.443	+0.425
Fabricated metal prods	+0.265	+0.169
Transport equipment	+0.223	+0.176
Machinery & equipment	+0.333	+0.218
Other manufactures	+0.156	+0.131
Unwt. average	+0.425	+0.319

7. Conclusions

This paper shows that there may be significant measurement error if policy sources only are incorporated into the effective protection modelling framework. Indeed, the present work is at a relatively aggregated (sectoral) level. With greater disaggregation to the industry or product level one would anticipate even greater divergence between policy-only and complete measures that allow also for international transactions costs. Given the decline in trade policy barriers, in industrial countries like the EU in particular, natural barriers are now in general a more important source of protection in the local and regional market and of bias against exporting. This clearly means that where tools such as effective protection are used to comment on allocation and distributional issues they should not omit natural barriers. Recognition of the relative importance of natural and policy barriers and of potential differences in the relative importance of each across sectors, between home and export markets, and between industrial and developing countries is also important for analytical reasons; for example in understanding the influence of trade barriers on agglomeration and trade patterns, and for designing policy and other reform programmes aimed at promoting exports. In line with the findings of recent gravity modelling (eg Baier and Bergstrand, 2001) that attaches a relatively minor role as yet to transport costs in accounting for the growth of world trade post 1950, this paper identifies considerable scope for lowering trade barriers and anti-export bias through the lowering of natural barriers. In the present context this is for the high income countries of the EU. As Limao and Venables (1999) show, there is even greater scope for trade expansion from this source in the case of many developing countries.

[1] For developed countries see Baldwin (1984) and Greenaway and Milner (1993) for developing countries.

[2] There is a literature that is critical of the use of the effective protection tool (e.g. Anderson, 1970, Ethier, 1977), in particular as a guide to general equilibrium output effects. The present focus is on measurement rather than interpretation issues, though there are theoretical contributions that emphasis the potential use of effective protection in analysing distributional effects (e.g. Jones, 1975 and Anderson, 1998).

[3] There is earlier, but limited, work in this area by inter alia, Waters (1970), Yeats and Finger (1976) and Clark (1981).

[4] There is evidence for earlier periods of falling international transportation costs. For example Harley (1988, 1989) for the period 1850-1913, when world trade also grew quickly.

[5] For simplicity a constant cost technology is assumed for transacting internationally. We are also assuming that import duties are charged on the transaction–inclusive (i.e. cif) value of imports. In the case of fob valuation for tariffs the term Πt_m disappears, but the value of the estimated coefficient $(\hat{a}_{ij})$ still depends on the level and pattern of natural as well as policy barriers.

[6] The inequality is likely to hold also where there are multiple inputs or the final good is an exportable. The transaction costs of importing intermediate goods originating from one set of countries are likely to be quite different to the transactions costs of exporting the final good to a potentially different set of destination countries. Although the interactive term in equation 9 $\left(e_j^I\right)$ disappears if tariffs are charged on the fob value, the possibility of distorting the measurement of effective protection by using distorted estimates of technical co-efficient remains.
[7] These are based on cif-fob comparisons of trade valuation and likely to be lower range or downwardly biased estimates for a number of reasons. They are likely to exclude certain additional transactions costs or barriers that apply to internationally rather than domestically supplied goods e.g. certification and internal transfers. Since they are trade-weighted measures they are also perversely weighted, with no or reduced weights applying to trade driven out by natural barriers.
[8] For expositional and presentational convenience we retain the single input model for estimation purposes. The total share of importable intermediate inputs in the total value of output in each sector is taken as the share of a single composite input subject to the trade-weighted average rate of either tariff or transaction cost on imported inputs into the sector from all sources.
[9] Weighted by the value of US final imports competing with this sector. Note that this excludes non-tariff barriers and therefore may downwardly bias protection in some sectors. Non-tariff barriers tend to be used by the EU against other countries than the US.
[10] This may upwardly bias the rate of input taxation on EU production competing with US imports as a result of product and source aggregation effects.
[11] This is consistent with a small country assumption on both the importables and exportables side. To the extent that it is inappropriate in the subsequent empirical application in this paper, we should view that estimates as providing upper bounds on the protecting or taxing effects of natural barriers.
[11] For expositional convenience we assume that the distortionless estimate of the technological coefficient $\left(\hat{a}_{ij}\right)$ is still as given by eq (3).
[12] For expositional convenience we assume that the distortionless estimate of the technological coefficient $\left(\hat{a}_{ij}\right)$ is still as given by eq (3).

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